

SUPPLEMENT TO THE MEDICAL JOURNAL OF AUSTRALIA

SYDNEY, SATURDAY, MARCH 15, 1924.

Section I.—Medicine.

(Continued.)

EPIDEMIC ENCEPHALITIS.

By J. B. CLELAND, M.D., CH.M. (Sydney),
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(Continued from Page 88.)

Specific Immunity.

Experimental results show that immunity can be obtained to the viruses of encephalitis. Such immunity is specific for each virus. Presumably the immunity lasts for a long time, perhaps for life. In the case of febrile herpes it would seem that human immunity is relatively short-lived.

From the pathological point of view and in this I have the endorsement of the Section of Pathology, we may sum up the position in Australia as follows:

(1) For many years we have had sporadic cases and occasional small epidemics of ordinary acute polio-encephalo-myelitis (infantile paralysis). Most of the cases have been spinal, occasional examples of the medullary form have occurred and rarely probable examples of the encephalitic type have been met with amongst the other cases.

(2) Since the recognition of *encephalitis lethargica*, cases conforming to this clinical entity have been recognized and reported, chiefly in Victoria.

(3) The Australian form of encephalitis known as "X-disease," of which two definite epidemics at least have occurred, is not lethargic encephalitis. It is either a distinct entity, occurring elsewhere, but not recognized owing to its resemblance to forms of the other two diseases or else it is the encephalitic type of ordinary acute polio-encephalo-myelitis. The manner of occurrence, clinical course and animal experiments incline one to accept the former alternative and certainly justify the retention for the present at least of a distinctive cognomen.

(4) The localization of the lesions in these two or three diseases explains the prevalent symptomatology. In individual cases of any of these diseases, the domain usually affected in one of the others may be involved with a consequent aping of symptoms.

References to Australian Cases of the Encephalitis Lethargica Type.

DRS. R. STAWELL, K. HILLER and W. J. DENEHY (THE MEDICAL JOURNAL OF AUSTRALIA, February 8, 1919, page 97) refer to fifteen cases altogether of encephalitis characterized more particularly by an influenza-like onset, sleepiness by day, restlessness by night, some fever, headache and diplopia. One case showed left facial paresis. There was an absence of neck rigidity or spasms.

DR. K. HILLER (THE MEDICAL JOURNAL OF AUSTRALIA, August 30, 1919, page 181) mentions having seen six cases during the previous four weeks characterized usually by diplopia at some time during the course of the case, ptosis usually affecting both eyes, marked somnolence and fever (the temperatures ranged from 37.9° C. to 38.9° C.). One patient was very restless and moved his right arm and leg in an irregular purposeless manner. Two of the six died.

DR. R. STAWELL (THE MEDICAL JOURNAL OF AUSTRALIA, October 16, 1920, page 387) stated that he had seen between fifty and sixty cases of this disease during the last fifteen months. The cases were characterized by headache, diplopia, lethargy by day and delirium and restlessness by night. The mortality was about 20%. He describes a case in a man aged twenty-nine, in which the illness began with a sore throat and he was light-headed. This was followed by a sudden spasm of both arms and hands and then by restlessness, insomnia, delusions and continued muscular spasms. Later he complained of seeing double. He finally passed into a stage of lethargy.

DR. I. S. LATHAM (THE MEDICAL JOURNAL OF AUSTRALIA, October 7, 1922, page 426) describes the case of a man aged twenty-seven who had an influenza-like illness. On recovery he had double vision, headache, drowsiness, nocturnal restlessness and delirium. He was in a typhoidal state for six weeks. He then became apathetic and a Parkinsonian syndrome developed.

DR. A. E. R. WHITE (THE MEDICAL JOURNAL OF AUSTRALIA, January 13, 1923, page 53) describes two cases. One was in a girl aged twelve. She developed headache, lethargy, occasional delirium and fever and slight facial paralysis. Four months later there was a relapse and she became very irritable, had screaming attacks and much headache and then became stuporose. She improved in a few days. This case is of particular interest inasmuch as the patient had evidence of a residual paralysis in the right leg and foot from an attack of polio-myelitis contracted ten years previously. This would suggest that immunity to the one disease did not lead to immunity to the other.

The second case was that of a boy of nine who had lethargy, headache, double vision, vomiting, nystagmoid movement of the eyes and vertigo. There was paresis of the facial and hypoglossal nerves on the right side. His mentality steadily deteriorated.

C. A. Hogg and Oliver Latham (THE MEDICAL JOURNAL OF AUSTRALIA, July 28, 1923, page 90) describe a remarkable fatal case of *encephalitis lethargica* with the pathological findings. The illness began with restlessness and sleeplessness followed by delirium and delusions. The hands were continually occupied in purposeless movements and the lower limbs showed coarse automatic movements of large amplitude. The ocular conjunctivæ were intensely congested; there was internal strabismus of an irritative nature in the left side and both eyes showed coarse nystagmoid jerks. The temperature ranged from 37.2° to 37.8° C. (99° to 100° F.). On the soft palate on each side three superficial discrete, oval, very shallow ulcers covered with a whitish exudation were found on the fourth day of illness. On the fifth day ulcers appeared on both corneæ and on the chest and back a macular morbilliform rash. Stupor and lethargy gradually supervened. In this case the ocular congestion and the ulcers in the palate suggest herpes and the question might be raised whether this case was an example of human herpetic encephalitis.

DR. S. F. McDONALD, before the Queensland Branch of the British Medical Association on January 31, 1921 (THE MEDICAL JOURNAL OF AUSTRALIA, March 19, 1921, page 240) described two cases of encephalitis. One case, a child of seven, showed feverishness, drowsiness, convulsions and then coma. The left side of the body was flaccid, the right slightly rigid. In the second case, that of a child of three, convulsions developed during whooping cough. These were followed by drowsiness and mental irritability. Dr. A. Jefferis Turner thought the condition might be due to plumbism. The latter also described a bulbar case of encephalitis and stated that he thought the Queensland cases of encephalitis were of the ordinary polio-encephalomyelitis type and not *encephalitis lethargica*.

DR. MATHEWSON, in connexion with these cases, refers to the epidemic in 1917 (frequently referred to as "X-disease"). He stated that he considered the microscopical appearances in this epidemic were identical with those met with in *encephalitis lethargica* and quite distinct from those of anterior polio-myelitis.

DR. D. R. TRUMPY, of Ipswich, (THE MEDICAL JOURNAL OF AUSTRALIA, September 2, 1922, page 282) refer to eleven cases. One was in a child of eleven, the rest in children under seven. There had been a sudden onset, irritability, drowsiness, convulsions and spasticity. The temperature averaged 39.5° C. (103° F.). In one case it reached 43° C. (109° F.). One child recovered. The patients usually died in thirty-six hours. Dr. J. A. Cameron, of Ipswich, mentioned having seen two patients with illness characterized by spasms and convulsions, one of whom recovered. Dr. M. S. Patterson of the same town had held a *post mortem* examination on one body which revealed no obvious lesions.

DR. G. H. BURNELL (THE MEDICAL JOURNAL OF AUSTRALIA, February 4, 1922, page 126) gives details of the after-history of a 1918 Broken Hill case in a child then aged seven. He describes her original attack. Seen twenty-one months later a typical Parkinsonian syndrome was present. He points out that he knows of no record of this syndrome as a sequela to acute polio-encephalomyelitis and as the symptom complex of *encephalitis lethargica* differs from that of the Australian "X-disease" he sees further support to the view that there are three separate human forms of encephalitis.

Various Opinions and Information.

In answer to inquiries from the Recorder of the Pathological Section, the following opinions and information have been supplied in connexion with epidemic encephalitis:

Dr. Keith Inglis finds that some patients who during life presented clinical signs which led to a diagnosis of encephalitis, showed histological appearances in the brain closely resembling those described in Europe and America as occurring in *encephalitis lethargica* and also resembling those described in "X-disease."

Dr. W. A. Lind, of the Victorian Lunacy Department, has not seen any cases of encephalitis and thinks that if such had occurred in the mental hospitals of Victoria, the cases would have been reported to him.

Dr. Oliver Latham, of the Mental Hospitals Laboratory, Sydney, would include under *encephalitis lethargica* all acute and chronic brain diseases when tuberculosis, syphilis, septic infection and trauma can be ruled out. He thinks that possibly some cases of psychoses and neuroses may also be included. Some of such cases, not giving reactions for syphilis, have shown on microscopical examination undoubted chronic or sub-acute encephalitis affecting especially the deep cortex and brain stem. Dr. Latham takes up the attitude that he must now regard such cases as most probably undiagnosed *encephalitis lethargica*. Some cases which resembled general paralysis of the insane but were not ordinary cases of this disease, and patients dying in public hospitals after a semi-acute brain illness sometimes likened to cerebral hæmorrhage, as well as a number of soldiers' brains that Dr. Latham has had to report on, are all, he now thinks, probably examples of *encephalitis lethargica*. Scarcely one case in three was correctly diagnosed and gross *post mortem* changes were not present as a rule. He considers that many cases of a peculiar form of hæmorrhage into the lateral and fourth ventricles are really part and parcel of the disease which a microscopical examination will reveal. Dr. Latham thinks it doubtful whether a case of "X-disease" or of *encephalitis lethargica* which had lasted two or three months, could be differentiated microscopically from a very early case of general paralysis of the insane.

CORRIGENDA.

In the Supplement to THE MEDICAL JOURNAL OF AUSTRALIA, of February 23, 1924, on pages 52 and 53, two illustrations of Dr. W. N. Horsfall's paper have been transposed. The illustration which appears as Figure III, should be the illustration of Figure IV, and *vice versa*. With this alteration the legends read correctly in their present positions.

In the Supplement to THE MEDICAL JOURNAL OF AUSTRALIA, of March 1, 1924, on page 66, a line has been repeated in type. The third paragraph of Dr. Oliver Latham's remarks should commence:

"A creatinin value of over five milligrammes per hundred cubic centimetres of blood nearly always meant a fatal outcome within two years."

Section II.—Surgery.

UROLOGY AS APPLIED TO CHILDREN. With Special Reference to *Bacillus coli* Infections.

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In opening the Section of Surgery of the Australasian Medical Congress held for the first time under the ægis of the British Medical Association it is my privilege to welcome those members who have travelled from the near and from the far distant parts of all the States in the Commonwealth and also those members from our sister Dominion of New Zealand who by their presence here show that we are as united in science as we were in the dark days of nine years ago when our lives and our liberty were at stake. Particularly do I extend a welcome to that distinguished visitor who has travelled some thirteen thousand miles to honour us with his presence. Not only do we welcome him as Past President of the great parent Association of which we are a unit, but as a surgeon and a scientist. The searchlight of his brain has illuminated for all time two dark places in surgery. I refer to his work upon the suppurative diseases of the brain and upon the growth and development of bone. Fellow medical men and medical women, I would ask you to extend an Australian welcome to Sir William Macewen.

The invitation of the Executive Committee to open the Surgical Section of the Australasian Medical Congress (British Medical Association) gave me the choice of a formal address or a paper upon some subject of general surgical interest. In choosing the latter alternative I was influenced by two factors, firstly, that there would be the opportunity of a general discussion; secondly, that the subject of urology as applied to children might perhaps appeal to others as it had appealed to me.

Before the Department of Urology at the Royal Alexandra Hospital for Children in Sydney was created some four years ago, I had made cystoscopic examinations in children as young as five years of age, but had not been much impressed with the utility of this method of investigation. The opportunities for making examinations were few and were separated by long intervals. Since then, however, increasingly frequent opportunities at short intervals have converted me into an enthusiastic advocate of the cystoscope in the investigation of urinary diseases of children.

I have learnt that young children, even infants, are subject to the same range of urinary diseases as their parents. I have also come to believe that many of the urinary diseases which exist in adult life, have their commencement in infancy or childhood; more especially is this true in the chronic bacillary infections of the urinary tract. It is with this group of disease that my remarks will deal.

When I commenced work amongst children little help could be gained from the literature, but in 1918 Hinman (1), of San Francisco, brought out an important paper on the use of the cystoscope in children, and Kretschmer

(2), of Chicago, in 1920 wrote a paper on the treatment of *Bacillus coli* infections of the renal pelvis in children.

These two papers convinced me of the necessity of seeing what work was being done in the urinary diseases of children in the surgical centres of Europe, England and America. In 1921 a visit to these centres was made and it was found that the whole subject of urology in children was still in the pioneer stage. No one man had done a great deal, but by piecing together the work done by the men at the various centres much help and valuable information was obtained. The greatest value of the visit came from the knowledge gained of the cystoscopes used in children.

To understand the development of urology in adults and more especially in children, it is necessary to refer briefly to the evolution of the cystoscope.

History of the Cystoscope.

More than a hundred years ago, 1807, Bozzini, of Frankfurt, conceived the idea of examining the inside of the human bladder. His instrument consisted of a straight tube which was inserted by suitable means through the urethra into the bladder and his only means of illumination was an ordinary tallow candle which he tried to reflect by means of a mirror down the centre of the tube. It was not a success, but Howard Kelly, of the Johns Hopkins Hospital, some ninety years later (1897) succeeded with the same type of instrument using air as a means of distention of the bladder and the light of an electric bulb reflected down the tube with the help of a head mirror. Kelly not only cystoscoped both males and females, but he was able to catheterize the ureters in both sexes. The difficulty in the use of the instrument in the male has led to its disuse, but it is still the standard instrument for females in the Johns Hopkins gynaecological clinic as well as in other clinics of importance. From 1807 till 1879 some attempts were made to get a satisfactory illumination by means of a glowing platinum wire loop but without success. In the year 1879 Edison brought out his incandescent carbon filament lamp and by this step made all endoscopic devices possible. In 1870 Trouvé, of Paris, introduced an instrument called the polyscope in which the illuminating element was a platinum spiral. Nitze invented a cystoscope with a system of lenses in the early 'seventies. About this period the diaphanoscope was produced for the purpose of transillumination of the bladder and abdominal wall. The lamp, a platinum spiral, was insufficient for the purpose, but it is stated that its use as a cystoscope was successful. In this instrument water cooling was used. In 1880 Leiter published in Vienna a catalogue of cystoscopes and other endoscopes with no less than eighty-two wood-cuts. Brenner in 1880 designed a direct cystoscope with a similar optical system. In the Nitze indirect cystoscope the operator looks at the bladder through a right angled prism as the submarine navigator looks at the sea through his periscope, while the Brenner instrument is used as the telescope is used by the navigator on an ordinary ship. Brenner five years later in 1892 brought out the first really successful irrigating and catheterizing direct cystoscope. In 1897 Albarran invented for the indirect cystoscope a metal finger or deflector. By this attachment the end of the ureteral catheter could be de-

flected and made to enter with ease the orifice of the ureter. All cystoscopes that we now use, direct or indirect, are modifications of these two master models. Up to 1901 the lamps of cystoscopes and other endoscopes were the "hot" or carbon filament type, but in that year the "cold" or metal filament lamp was invented. Since the adoption of this improvement it is impossible to burn the bladder wall. With the old hot lamp the early cystoscopists literally blazed the trail of the new science. In those days "simple" ulcers of the bladder were quite common. Since the invention of the cold lamp I have not seen one.

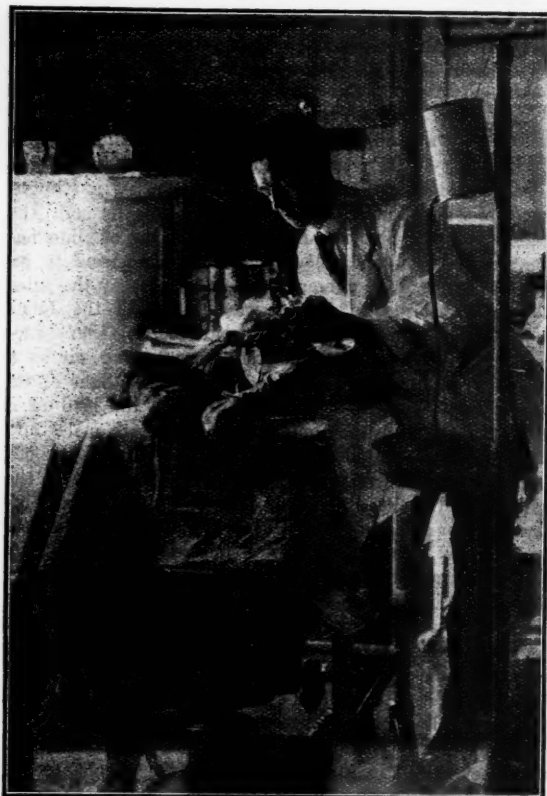


FIGURE I.

Showing position of baby prepared for cystoscopy. Note the abduction of thighs.

From 1910 to the present day smaller and smaller cystoscopes have been made and younger and younger children have been cystoscoped. Although we are now approaching finality of design in the adult instruments, we are not quite so happily situated with the children's cystoscope.

I cannot close this short history without reference to the direct cystoscope with no lens system designed about 1907 by Elsner and later modified by Braasch of the Mayo clinic. In 1913 Braasch designed a child's cystoscope on the model of his adult instrument. Both of these instruments I use in over 80% of my work. Of the indirect instruments for children I find up to the present the one

made by Woolf, of Berlin, about the most satisfactory, but I hear on good authority that the Wappler Company of New York are bringing out a child's cystoscope based on their adult Brown and Buerger pattern. The British firm, the Genito-Urinary Manufacturing Company of London, established since the war, are making very high grade cystoscopes and I look forward to the early appearance of a child's cystoscope on which they are working.

Technique of Cystoscopy and Renal Pelvic Lavage.

A reference to Figure I. will show clearly that it differs very little from that of the adult examination. No

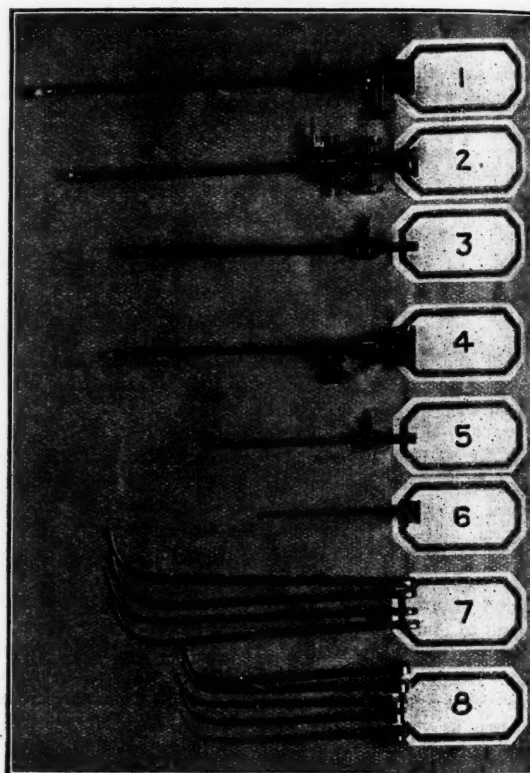


FIGURE II.

Showing relative size of adult and child cystoscopes; also adult and child metal bougies.

- (1) Swift Joly Universal Cystoscope; indirect; adult. (Made by Genito Urinary Manufacturing Company, London).
- (2) Brown and Buerger Universal Cystoscope; indirect; adult. (Made by Wappler and Company, New York).
- (3) Braasch Direct Cystoscope with Double Ureteral Catheterizing Channels; adult. (Made by Electro Surgical Instrument Company of Rochester, New York).
- (4) Indirect Cystoscope with Single Ureteral Catheter Channel; child. (Made by Wolfe of Berlin).
- (5) Direct Cystoscope, Braasch Model, with Single Ureteral Catheterizing Channel; child. (Made by Electro Surgical Instrument Company, New York).
- (6) Holmes Naso-Pharyngoscope which can be used as a simple indirect examining cystoscope in children. (Made by the same firm as the Braasch instrument).
- (7) Metal Bougies for Adults.
- (8) Metal Bougies for Children.

special table is required as the degree of abduction of the thighs in young children admits of their assuming with ease the frog position. They can lie on their backs on a

flat surface and touch the table with the lateral or outer surface of their thighs. The real difficulty is in the introduction of the cystoscope in babies.

Kretschmer has examined the bladder and catheterized the ureters of a female baby of seven months and a male baby of fourteen months. The youngest so far that I have similarly examined is a female baby of ten months and a male of one year and nine months. The baby in the illustration is a boy of one year and ten months. The size of the urethra varies, but the narrowest part found is in the anterior centimetre and at the triangular ligament or urogenital diaphragm. Sometimes it is necessary even in children of one or two years of age to dilate the urethra or slit the meatus for the purpose of admitting the cystoscope. Although adult dilating metal bougies can be used, it is better to get a special set made.

Figure II. shows the relative size of the bougies for the adult and the child. In catheterizing the ureters in children it will be found that the orifices are relatively further apart than in the adult and relatively further away from the vesical orifice. It is of interest that even the youngest babies examined can with very few exceptions take the usual adult size of ureteral catheter, No. 5 Charrière scale.

The *meatus urinarius* and external genitals are cleansed in the ward with ordinary soap and water and, when male children are under the anæsthetic, with ordinary commercial alcohol. This is too severe for female children and a 1% *liquor cresolis saponatus* (British Pharmacopœia) is used instead. Dr. A. H. Boyd, the Resident Pathologist at the Royal Alexandra Hospital for Children, tested bacteriologically this method in fourteen observations on an equal number of boys and girls. The organisms grown from the meatus before the application of the antiseptic were two in type, *Staphylococcus albus* and a diphtheroid organism. The former was found in both sexes, but the latter in two girls only. After application of the antiseptic the meatus was sterile in all cases and the anterior portion of the urethra was sterile in twelve children out of fourteen. In the two exceptions *Staphylococcus albus* was grown. For practical purposes it is not necessary to wash out the urethra as is borne out clinically by the absence of any evident reaction in the whole series of over one hundred and forty cystoscopic examinations carried out in children during the past eighteen months at public and private hospitals. On one occasion an increasingly high temperature developed in the few days following an examination, but the appearance of a measles rash on the third day relieved our anxiety.

The lubricant for the cystoscope used is a water soluble preparation known as "Lubafax." It is composed of glycerine and starch in which is dissolved oxy-cyanide of mercury in the strength of 1 in 2,000. The cystoscope is sterilized by washing in warm water and soap and then immersing for five minutes in commercial alcohol about 95% purity. The ureteral catheters after use are washed in running water and then allowed to siphon over from a large jug of sterile water for about two hours. They are then hung up straight to dry overnight. When dried they are kept in glass tubes about fifteen centimetres (six inches) longer than the length of the catheter. The ends of these tubes are plugged with sterile cotton wool in the

interstices of which are placed some "Formalin" tablets. At room temperature of 18° C. (64.4° F.) or over this insures sterilization in forty-eight hours. The catheters are kept in the weak formaldehyde vapour for three days at least before being used again.

If the surgeon prepares himself as for an operation the whole procedure of cystoscopy, ureteral catheterization and lavage of the renal pelvis can be carried out under aseptic conditions. All cystoscopic examinations are carried out under a general anæsthetic. Ether is used in all cases preceded by a few drops of ethyl chloride. The ether is administered by the "open" method by being dropped on to layers of gauze stretched on a wire frame and placed over the child's face. No anxieties either during the anæsthesia or afterwards have been met with.

When the cystoscope is introduced, a specimen of the bladder urine is taken into a sterile vessel for a bacteriological and cytological test. The bladder mucous membrane is systematically examined and afterwards the right ureter is catheterized through the single channel of the cystoscope; a specimen is collected through a sterile test tube for a test similar to that of the bladder urine. Two to five cubic centimetres of 0.5% to 2% silver nitrate in distilled water are injected into the renal pelvis through the catheter by means of a five cubic centimetre glass syringe. The amount and strength of the solution varies according to the age of the child and the resistance of the infection to treatment. A similar step is carried out on the left side. If the child's urethra will admit of it, time is saved after the passage of one ureteral catheter, by withdrawing the cystoscope and leaving the right ureteral catheter *in situ*, while the cystoscope is reinserted at the side of this catheter and the left kidney pelvis treated in a similar way. The lavage is repeated once a week.

The whole procedure is tedious; the average length of time occupied in taking the three specimens of urine and injecting the silver nitrate into the renal pelvis on both sides is three-quarters of an hour. The induction of anæsthesia is included in this period. Most of the time is occupied in taking the specimens of urine from each kidney. By giving the child plenty of water during the three hours before the examination is made, much wearying delay is avoided.

Chronic Bacillus Coli Communis Infection of Urinary Tract.

Beyond diagnostic cystoscopic examinations made for colleagues on the staff, little work was done in the Department of Urology in the Royal Alexandra Hospital for Children before March, 1922. Since then, however, the treatment of chronic infection of the urinary tract has been undertaken and all the other cases met with have arisen in the course of this work. No attempt was made to treat a large number of patients: the endeavour rather was to keep the numbers down so as to admit of accurate observations being made from a clinical and bacteriological point of view. When some principles of treatment could be deduced from these observations, there would be little likelihood of a dearth of clinical material. No child was taken before it had been subjected to at least two months medical treatment by vaccines and urinary antiseptics preceded by alkalis in the acute stage of the infection. There

is no doubt that the great majority of acute infections of the urinary tract are cured by these means, but a certain number pass on to the chronic stage. Some of the children treated in this series have been ill for many months and some for years.

Silver nitrate was chosen as an antiseptic throughout not necessarily because it was the best antiseptic, but because the series was a small one and for the sake of uniformity. In the whole series this was the only therapeutic treatment. No drugs were given by mouth.

The Action of Silver Nitrate Injections.

For many hundred years the virtues of lunar caustic have been known to the medical profession. How it acts is not easy to answer off hand. In the comparatively weak solution of 0.5% to 2% its direct antiseptic action on the bacteria in the pelvis of the kidney is difficult to imagine, as the soluble chlorides in the urine quickly precipitate the solution of silver nitrate into an insoluble silver chloride. If through the cystoscope the ureteral orifice is watched during the injection of the renal pelvis, a copious milky fluid will be seen escaping by the side of the catheter. This milky fluid is the silver chloride.

In one of the American clinics some two years ago experiments were carried out on animals. Silver nitrate in weak solutions was injected into the renal pelvis in a series of dogs; these dogs were killed at varying intervals up to fourteen days. The changes that were constantly observed, were desquamation of the epithelium lining the pelvis and ureter and submucous infiltration of small round cells. In fact an inflammation was set up which lasted from ten to fourteen days. Although the exact details of the technique of the experiments did not quite reproduce those used clinically in the human being, yet in the main they corresponded sufficiently to suggest an explanation of the effects of silver nitrate on bacterial infections of the upper urinary tract. In chronic pyelitis the mucous membrane of the pelvis of the kidney seems to become indifferent to the presence of the foreign organisms. In acute pyelitis as in acute infections of other mucous lined cavities in the body there is a mobilization of Nature's great white army, the leucocytes with their auxiliaries which are quite capable in the great majority of cases of completely defeating the raids of the invading organisms. At other times the issue is not so clearly defined; there is apt to follow a form of guerilla warfare extending over months or years. Silver nitrate may act by calling up reinforcements to help those troops worn out by the long campaign. In other words, it is an indirect rather than a direct action.

As a routine, stone in the urinary tract was excluded by X-ray examination and tuberculosis by a search for the bacillus in the sediment of a twenty-four hour specimen of urine, amplified by a guinea pig inoculation where indicated.

Standard of Cure.

Kretschmer in his work was not satisfied unless the urine of the patient was pus-free and germ-free. This is the standard taken in the present series. I am indebted to Dr. Marjorie Ross and Dr. A. H. Boyd, of the Pathological Department of the Royal Alexandra Hospital for Children, for their painstaking work in making a long series of careful bacteriological tests. Progress in the

course of treatment was measured by counting the bacteria contained in a cubic centimetre of the urine from the bladder and each kidney. The method of counting used was the same as is used in the counting of organisms in the milk supply of the hospital. The urine is diluted in the first instance to 1 in 10,000 with normal saline solution or to that degree of dilution where a cubic centimetre of the urine and normal saline solution when plated out on agar will show a countable number of colonies. Each colony is taken as representing one organism. A sum in multiplication of the number of colonies by the number of dilutions gives the organisms in the cubic centimetre of the urine. At the onset of treatment these figures read like distances of the nearest stars or a quotation in exchange expressed in German marks. "Uncountable in dilution of 1 in 100,000,000" is not an unusual quotation. The highest content actually counted was 5,000,000,000,000, organisms per cubic centimetre. Ordinary language fails in an attempt to put that number in writing.

Of the thirteen patients treated nine were cured, one was relieved, two were unrelieved, and one died. The one patient who died, should not perhaps be included in the series as he was at the terminal stage of the disease on admission to hospital, but as an autopsy was obtained, much valuable information would be withheld if he were excluded. The best way to illustrate the cases cured by the treatment is to give the history of one in detail with a selection of the photographs of the actual cultures made from the beginning to the end of the treatment. See Figures III. and IV. The patient chosen was the very first treated in the Children's Hospital and, as shown by the clinical history, appeared anything but favourable at the outset. In addition to the pyelitis associated with the *Bacillus coli communis* infection there was clear evidence of super-added nephritis. Step by step, however, under the influence of the silver nitrate she improved until at the end of three months she was discharged cured of the bacillary infection of her urinary tract.

The patient was a female, aged three years and eight months. She was one of a family of four, the other three were living and healthy. Four had died in infancy. She had had gastro-enteritis at the age of fourteen months, measles and whooping cough at two years. She was admitted in September, 1921, with swelling of the face of six days' duration. The onset was sudden with malaise, headache and vomiting. On admission the urine contained pus cells, red blood cells and a few granular and epithelial casts. Under purgatives and alkalies the oedema of the face improved, but the pyuria persisted in spite of autogenous vaccines and hexamine after the urine had been acidified by acid sodium phosphate. She was discharged from hospital on December 13, 1921, to attend as an out-patient for the administration of vaccines.

She was readmitted on January 5, 1922, and medical treatment continued until March 23, 1922, when she was referred by my colleague Dr. Macdonald Gill for cystoscopic investigation and lavage of renal pelvis, if indicated. The pyuria and bacilluria had remained stationary throughout her illness uninfluenced by treatment. The progress of the patient under treatment is illustrated in Table I. (see page 96).

The other patients who were cured by the treatment, presented no particular feature of interest beyond the fact that one patient, a girl aged ten, required sixteen injections.

tions before the urine became sterile. An observation made three months after the cessation of treatment showed that the urine was still sterile and free from pus.

The term "cured" does not imply that the illness may not recur at some future date. The time that has elapsed since the patients were treated is too short to claim more than the sterility of the urine and its freedom from pus on discharge from hospital.

Of the one girl relieved, a measure of her relief is shown by the reduction of the organisms in the urine from a bacterial count of many millions down to five thousand per cubic centimetre on discharge from hospital at the request of the parents. They believed that the repeated anesthetics might affect the child's brain.

The two unrelieved were both boys, one of eleven-years,

bladder was emptied during the collection of urine through the ureteral catheter, clear water from the bladder irrigation would flow up the ureters and run out of the catheter. If the bladder were emptied, turbid urine flowed from the renal pelvis through the ureteral catheter. This reflux of irrigating fluid from the bladder to the kidney pelvis might have been due to the presence of the catheter in the ureter; so to determine whether the uretero-vesical valve was physiologically active, a cystogram was taken and it clearly shows that the solution of sodium bromide allowed to flow from the moderate height of seventy-six centimetres (two feet six inches) above the bladder not only filled the bladder, but escaped through the patent uretero-vesical valves and up the ureters to the height of the sacro-lumbar junction. During the physiological act of micturition the pressure is greater than that used in the test and there

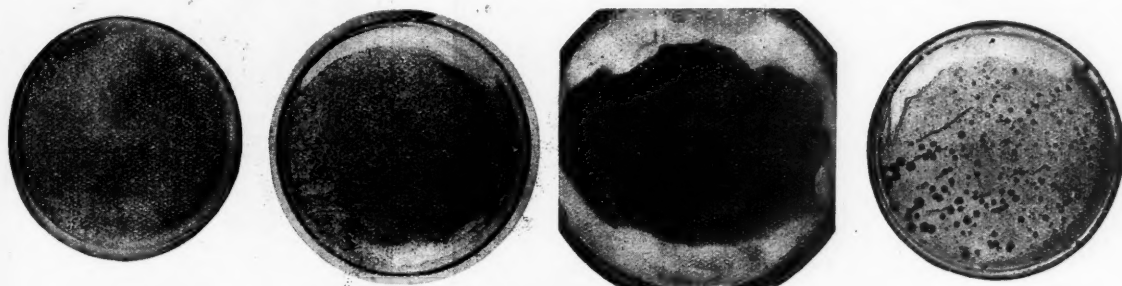


FIGURE III.



FIGURE IV.

Reproductions of actual photographs of cultures of bladder urine at weekly intervals showing progress during treatment. The urine was diluted to 1 in 10,000 in all cultures except that in the last illustration where the urine was undiluted. These photographs were taken from the first case treated.

the other ten years. No influence whatsoever on the disease was shown by the treatment either by increasing the amount of the injection to five cubic centimetres or increasing the strength of the silver nitrate solution from 0.5% to 2%. The first boy had passed a stone through the urethra after an attack of renal colic two years before he came under my observation. Since the passage of the stone he had suffered from bacilluria. The second boy had suffered with his water since he was a baby, a period of at least eight years. This fact was obtained from his mother. He looked well and had a good colour, although his urine had a column 2.5 centimetres of pus in an ordinary 180 cubic centimetre specimen glass. The ureteral orifice on both sides was relaxed and gapping. Unless the

is nothing to prevent the septic urine of the bladder reaching up to the kidney and defeating any attempt of a cure by natural means. The X-ray evidence in this boy's case shows that, strong as our belief may be that most bacillary infections of the urinary tract are blood borne and descending, there are yet some cases that may be infected by the direct ascending route of the mucous channel of the ureter.

This boy had advanced pyelo-nephritis, but yet retained sufficient renal function to carry on the normal requirements of the body. Since the discharge of this patient from the hospital, his mother states that his appetite has improved and he looks forward to every meal. Although measured by a bacterial and cellular count of the urine, no improvement was evident while under treatment, yet

it is just possible that some improvement may have been brought about by the treatment.

The last case of this type of disease to be discussed is of a boy just under two years of age who died while under observation. His mother stated that ever since his birth his "water" had not been "right." He was subject to attacks of feverishness accompanied by swelling of the abdomen which disappeared as the attack passed off in a few days. When first I saw him the abdomen was flat and both kidneys and the bladder showed gross infection. After low specific gravity and contained a maximum degree of pus. When the urine from both kidneys was collected, both kidneys were palpably enlarged. The urine was of two injections of silver nitrate one of his attacks came on



FIGURE V.

From a photograph of child who died, two weeks before death. Note distended abdomen from bilateral pyonephrosis.

and I found the right kidney much enlarged; it filled almost half the abdomen. A photograph of him was taken at this stage and is reproduced (see Figure V.). The right kidney was opened and drained through the loin. Nearly a litre of foul smelling thin pus was evacuated.

He improved for a few days, but died a fortnight after the operation.

A *post mortem* examination was made and a photograph of the whole urinary organs shows the advanced state of the disease at the time of the patient's death (see Figure VI.). The bladder was thickened, both ureters and pelvis were dilated, the right especially. The cortical tissues of both kidneys were flattened and were the seat of multiple discrete abscesses.

This case was not one of a pure infection of the urinary tract, but an infection superimposed on a congenital bilateral intermittent obstructive lesion in the ureters. Ob-

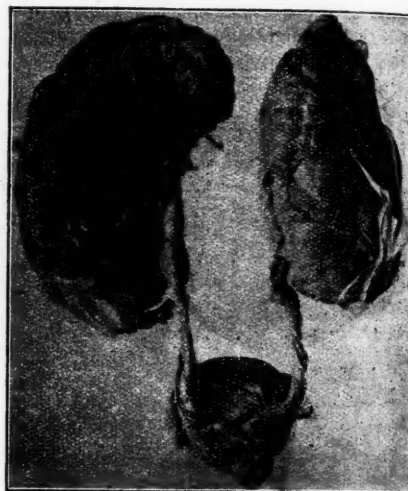


FIGURE VI.

From a photograph of kidneys ureters and bladder of same child. The photograph fails to convey the size of the kidneys during life. Note the multiple cortical abscesses well seen in left kidney.

servations in adults and in children would lead me to believe that these congenital obstructions are much more

TABLE I.

DATE	PRESENCE OF PUS CELLS			NUMBER OF ORGANISMS PER CUBIC CENTIMETRE			TREATMENT
	Bladder	Right Kidney	Left Kidney	Bladder	Right Kidney	Left Kidney	
7.4.22	+	+	+	600,000,000,000	2,300	10,000,000	Lavage of renal pelvis with 1.5 c.cm. of 0.5% silver nitrate
10.4.22	+	+	+	+	+	+	No treatment
7.5.22	+	+	+	+	+	+	Two c.cm. of 1% silver nitrate
12.5.22	+	0	+	1,400,000	Sterile	Less than 1,000	Two c.cm. of 1% silver nitrate
19.5.22	3 pus cells in field	Not tested	Not tested	217,000,000	Not tested	Not tested	Two c.cm. of 1% silver nitrate
26.5.22	6 pus cells in field	0	0	7,600,000,000	160	10	Three c.cm. of 1% silver nitrate
2.6.22	0	0	0	0	0	0	Three c.cm. of 1% silver nitrate
10.6.22	0	0	0	0	0	0	No treatment

In July, 1923, thirteen months after cessation of treatment she was readmitted with œdema of face and hands, but the urine was free from pus and was sterile on culture.

common than has been previously thought.

This series, small as it is, includes all types of infection by the *Bacillus coli communis*, from the mild chronic cystitis and pyelitis to the advanced pyelonephritis and we are justified in making the following conclusions:

(1) That the majority of chronic *Bacillus coli* infections of the urinary tract in children can be relieved and some may be cured by lavage of the renal pelvis with solutions of silver nitrate.

(2) If this treatment fails then some superadded organic disease may be suspected.

References.

(1) Frank Hinman, "The Cystoscopic Study of Urologic Conditions in Children," *The American Journal of Diseases of Children*, May, 1919, page 305.

(2) Herman L. Kretschmer, "The Treatment of Pyelitis in Infancy and Childhood," *The Journal of the American Medical Association*, November 13, 1920, page 1,303.

DR. H. S. NEWLAND congratulated Dr. Gordon Craig on his paper; it marked a very distinct step forward in the history of urological surgery in children in Australia. The paper was characterized by that patience, imperturbability and thoroughness so typical of the work done by Dr. Craig.

Howard Kelly had, he believed, been stimulated in his work by Pawlik, of Prague. He had himself seen Pawlik pass a metal ureteral catheter up the right ureter of a female patient and wash out the pelvis with silver nitrate solution. It sounded incredible, but it was a fact. Dr. Craig had limited his paper rigidly to chronic infections of the renal pelvis and he hoped that members in discussing the paper would be equally definite.

Applying the instruction to himself, he would refer to one case only in his own experience. It was that of a little girl about three years of age who had been admitted to the Adelaide Children's Hospital for the treatment of club-foot. The child had developed measles and later had returned to the surgical wards with pyo-bacilluria due to infection with the *Bacillus coli communis*. Alkalinization of the urine and later prolonged administration of vaccines having failed to effect a cure, a cystoscopic examination had been carried out. He had been surprised to find that the left ureteral orifice was dilated to a size represented by the end of the little finger. It was obvious that no local treatment of the renal pelvis would cure the condition. The kidney and ureter had therefore been removed and the ureter had been seen to be greatly dilated throughout its entire extent. Some of Dr. Craig's lantern slides had shown strictures of the ureter, but he suggested that in some instances the strictures were relative rather than actual.

He hoped that the experience of others would contribute more of value to the discussion than he could bring forward from his own observations in this field.

DR. R. M. DOWNES was afraid that he was in the position at the moment of the man who wanted to say something rather than of the man who had something to say.

Dr. Gordon Craig had done a great service in showing what excellent results could be brought about in children by washing out the pelvis of the kidney with silver nitrate in resistant cases of *Bacillus coli communis* pyelitis, a method of treatment that was of no great value in adults. He had had a boy, aged nine, under observation who had had symptoms of *Bacillus coli communis* pyelitis since infancy. With considerable difficulty his renal pelvis had

been treated a few times with silver nitrate. He thought that the mother's conviction that he had been greatly improved by each treatment was imaginary, until I learnt from Dr. Craig that what was so valueless in adults was quite efficacious in children.

Cases of *Bacillus coli communis* pyelitis were common especially in infants; they formed a large majority of the surgical diseases of the urinary organs in children. As a rule the diagnosis was easy as long as the condition was looked for. One point of interest to the surgeon was its ability to mimic other disease, especially appendicitis. It was not difficult to find instances of normal appendices that had been removed on account of the symptoms produced by a pyelitis. A routine habit of examining the urine before operation in cases of apparent catarrhal appendicitis undoubtedly prevented mistakes in diagnosis. On the other hand they should not be deceived by the finding of a few red or white corpuscles in the urine into diagnosing a pyelitis or other urinary condition as the cause of tenderness and rigidity in the right iliac fossa, accompanied by fever; when pyelitis was at the root of the clinical picture the result of the urine examination would be much more conclusive.

Cystoscopy in children was very fascinating, but it was often accompanied by considerable technical difficulties, chiefly in regard to the supply of good instruments and spares. He regarded the indirect vision cystoscope (especially Wolff's) as the most suitable for general use, but the lamps were so small in instruments of a size suitable for children that it was often difficult to obtain sufficient illumination for a satisfactory examination. In addition ureteral catheterization with the indirect cystoscope was often much more difficult than in the adult, on account of the small bore of the ureters. Though it was much less easy with the direct vision cystoscope to locate the ureteral orifices, which were not nearly so easily visible in children as in adults, it was simpler to catheterize children, as the catheter did not require to be bent in its passage from the instrument to the ureteral orifice.

In the majority of cases of *Bacillus coli communis* pyelitis little was learnt by cystoscopy beyond the elimination of other pathological conditions of or in the bladder which were suggested by the pain on micturition; such elimination was often very necessary. Sometimes pieces of lymph or flakes of pus were seen, at other times small superficial ulcers. In rare cases only was there a wide-spread appearance of inflammation. Usually the urine from both kidneys was affected.

Regarding treatment cure usually followed the administration of full doses of citrate of potash. Vaccines had little value in those few patients who were resistant to alkalinization of the urine.

Urinary calculi could be said to be common in children. Only ten children have been treated for this condition in the last three years at the Children's Hospital, Melbourne. In four the calculi were renal, in three ureteral, in two they were in the bladder and in one in the urethra. The children with renal calculi were all over eleven years of age; the symptoms were chiefly pain in the renal region and hæmaturia. The pain as a rule was not severe and did not tend to radiate to the groins and testes as much as in adults. X-ray examination was almost essential for a pre-operative diagnosis. Oxaluria which was not uncommon in children, was sometimes accompanied by much more severe pain than was seen in renal calculus and when associated with hæmaturia it was impossible to rule out calculus without X-ray examination. The presence of crystals of calcium oxalate in the urine, though it might

explain the symptoms, did not justify the surgeon in deciding that it was their sole cause, for it still might be associated with calculus.

The proportion of ureteral calculi seemed higher than in adults. Typical renal colic was unusual and the course of the disease might be more chronic. As the distance from the parietes to the pelvic portion of the ureter was so much less in children than in adults, it followed that the difficulties of extra-peritoneal operation was considerably less.

Several of the patients with urinary calculi, particularly vesical, had been circumcised previously with the object of relieving the symptoms. This was an operation which was very much overdone and was frequently recommended without full consideration of its need or probable benefit as a cure for all sorts of conditions. Many infants were seen at a children hospital for whom circumcision has been advised, who had no phimosis and merely required separation of the adhesions between the *glans penis* and prepuce.

Tuberculosis of the kidney fortunately was not frequently seen. Its course was usually rapid. Frequency of micturition, dysuria and hæmaturia were the more common order of symptoms. Cystoscopy was rendered difficult by the small bladder capacity, which was only six cubic centimetres in one of his patients aged thirteen and a half years. The bladder was considerably affected in every case. Miliary tubercles and ulceration in and about the trigone were observed in two patients within six weeks of the onset of symptoms. In one in whom the left kidney was obviously affected and the right kidney had not definitely been shown to be sound by ureteral catheterization, the diseased kidney was removed with satisfactory results.

There seemed to be a good field for investigation in the urology of children, especially in regard to tests of renal function, concerning which very little information was to be obtained; but such work was hampered at present by the difficulty of obtaining German cystoscopes and lamps and the apparent impossibility of getting instruments suitable for children from any other country.

DR. R. GORDON CRAIG in reply said that whilst it was possible to use an ordinary cystoscope of adult size for female children over the age of eight years, smaller special instruments were required for girls under that age and for most male children.

He was of opinion that stricture or narrowing of the ureter played an important part in the causation of pyelonephritis. Braasch had shown that injection of living organisms intravenously did not produce infection of the kidney unless the corresponding ureter was obstructed. It was a curious fact that even in children of twelve or eighteen months of age an ordinarily sized ureteral catheter (No. 4 or No. 5 Charrière) could be used.

AN ADDRESS ON LUNG SURGERY.

SIR WILLIAM MACEWEN, F.R.S., on being invited by the President to address the members of the Section of Surgery, offered them a choice between some general surgical reminiscences and some observations of his own, which he acknowledged were somewhat heterodox, bearing on the problems of lung surgery. The meeting decided to hear Sir William's remarks on the latter subject.

At the outset he reminded members that the results of experimental work upon animals under artificial conditions were not always in accord with clinical observations. The physiologists taught that it was the atmospheric pressure that kept the lung expanded and in contact with the parietal pleura and that if the pleural cavity were opened, collapse of the lung would occur and death might follow. This teaching had been widely accepted, so that on the

Continent and elsewhere operations on the thorax were conducted with the aid of elaborate apparatus designed to overcome the risk.

Again a lung which was expanded, contained in its periphery a large amount of blood and if a cutting operation were performed on such a lung, hæmorrhage would be a serious factor. He believed that atmospheric pressure was not the controlling force and that even if it did play some part, there must be some other factor at work.

In operations upon the abdomen it was observed that the abdominal viscera coalesced and that atmospheric air was very seldom enclosed.

He cited the case of a man who had sustained extensive fractures of the ribs on both sides with consequent double pneumothorax and who was dying from inability to inspire air. He was relieved by aspiration, but this could not be continued. Accordingly the pleura on one side was widely opened and the parietal and visceral layers were brought into contact. Following the operation the lung expanded and the patient improved. Impressed by this observation he treated the other side similarly and the patient rapidly recovered. These and other clinical observations had led him to the conclusion that there were forces other than atmospheric pressure to be considered.

Sir William instanced the familiar example of the schoolboy's sucker, a moistened disc of leather to the centre of which a string was attached and which when pressed against a smooth, flat stone enabled the stone to be lifted from the ground. Physicists said that this phenomenon was due to atmospheric pressure, but if the experiment were repeated inside a bell-jar from which the air had been exhausted, the sucker would carry as much weight inside the jar as outside.

A distinguished physicist was asked for his explanation of the force at work and gave it as molecular cohesion. If two surfaces of glass which were optically perfect, were placed in contact, the same force was found operating to prevent their separation. If two surfaces of glass not optically perfect were used, the same result might be obtained by the introduction of a small amount of fluid between the surfaces; the result still held even if a number of holes were drilled through the glass.

As a practical application of these observations the chest might be opened and the subsequent collapse of the lung overcome. By manipulation of the lung and pressure on the elastic thoracic wall the two layers of pleura were brought into contact and molecular cohesion would close the cavity unless the lung were greatly shrunken when it would be necessary to inflate it. In this manner tumours of the lung might be removed, but it was necessary to keep the pleural surfaces moist during the operation.

In conclusion Sir William gave the details in a number of instances in which total extirpation of the lung had been carried out with success.

The President conveyed the thanks of the Section to Sir William Macewen for his stimulating address.

AFTER TREATMENT, COMPLICATIONS AND END RESULTS OF PROSTATECTOMY.

By BASIL KILVINGTON, M.D., CH.M. (Melbourne),
Honorary Surgeon, Melbourne Hospital.

In discussing the after treatment and complications of prostatectomy I shall briefly give the course I adopt myself and shall confine my remarks to the suprapubic operation. Of the treatment of shock I need say nothing.

The question of one or two stage operations does not come within my scope, but I place considerable importance

on the blood urea test as a guide. From a clinical aspect patients with infection of the bladder and kidneys are unsuitable for a one stage operation, as are also patients with poor cardiac and pulmonary organs.

A two-stage attack on the prostate is more unsatisfactory from a technical point of view as retraction of the bladder is more difficult and any suturing of the bladder and abdominal wall less neat. So that unless the indications are very definitely against it, I prefer the one stage procedure when the wound will heal more quickly.

In bronchitic subjects I regard ether anaesthesia as a real danger; most of these patients will take chloroform very carefully given. In the worst cases intra-spinal injections of "Novocaine" will give insensitiveness for long enough time to complete the operation, but unfortunately it is not always completely effective.

First.

Bleeding occurs at two stages at or shortly after the completion of the operation. I have tried the plan described by Thomson Walker of ligaturing bleeding points, but have not often succeeded in doing this. It is satisfactory when a definite spouting artery can be seen, but when the blood wells out of the prostatic bed it is useless.

As a routine I employ a strip of gauze about 2.5 centimetres wide and up to sixty or ninety centimetres in length packed in the cavity and brought out of the large bladder drain tube. This I remove in twenty-four hours to avoid sepsis and then at once wash out the bladder. In more severe cases I adopt a plan described to me by Mr. Syme of having a rolled up piece of gauze attached to the centre of a piece of silk. One end of the silk passes out of the tube and the other is drawn through the urethra by attachment to a catheter. This two-way silk allows of very firm pressure, if needed, and the plug is removed through the suprapubic wound in twenty-four or thirty-six hours.

Second.

There is no doubt that much bleeding adds greatly to the mortality not only by lowering resistance, but the clots greatly add to the risk of sepsis and should be removed as soon as it is safe to do this.

Delayed bleeding generally shows after a week or ten days and is fortunately rare. In most cases it is unavoidable and apparently in such is due to a separating slough opening a vessel. In other cases it seems to follow catheterization done to wash out the bladder and may be due to the point of the instrument disturbing a clot in a vessel. There is no doubt that whenever bleeding is feared, great reluctance should be shown to catheterization and even washing out through the suprapubic wound is a source of anxiety. In ordinary delayed bleeding I give morphine hypodermically and wash out the bladder suprapubically and finally run in 3.5 cubic centimetres of adrenalin. Patients with severe symptoms need an anaesthetic while the clot is being removed and the cavity plugged. The after treatment is difficult as one is torn between the fear of disturbing the clot in the vessel by irrigation and the risk of sepsis by leaving the clot to decompose in the bladder.

I am not satisfied that it is the "dirty cases" especially that provide secondary hæmorrhage. Stone associated with prostatic enlargement does not alter the risk. The great danger after a prostatectomy is undoubtedly local

sepsis in the cavity which spreads to the kidneys and in a less serious way to the epididymis.

The signs of this are some dryness of the tongue, rise of temperature and especially rigors. This danger undoubtedly dominates the whole after treatment. Local tags of tissue in the prostate neighbourhood undergo sloughing and promote sepsis and it is always well at the close of the operation to expose the prostate bed under a good light and to cut away all tags. At the same time the curtain of mucous membrane which sometimes narrows the internal meatus, can be clipped off or a V-shaped piece excised.

The danger of sepsis appears most in those small densely hard organs which are extremely difficult to remove with the finger. I have now given up the attempt to do the operation this way and clip most of the prostate away with long scissors and forceps. The assistant has his finger in the rectum and before every cut with the scissors, the relation of the tissue to be removed to the rectum is made out. In these cases very little tissue really requires to be taken away. This procedure is followed by much less shock and very much less sepsis than the one usually performed.

When the gland is enucleated which is done in the horizontal position, the patient is placed in the Trendelenburg position and the bladder well exposed under a good light. All blood clot is removed, the cavity is plugged and tags of tissue are removed with scissors. Then a very large tube is placed in the hole and the bladder sutured firmly around it with ordinary catgut. This enables all urine to be collected through this tube and keeps the wound dry till the tube is removed which is somewhere about the fifth day. This suturing is usually impossible in the two-stage operation. Through the lumen of the rubber tube the end of the gauze plug in the prostatic cavity is passed and can be removed at the end of twenty-four hours without disturbing the tube.

As a rule with this procedure there is no serious bleeding and the patient is left undisturbed till the plug is removed.

From this time on the bladder is washed out twice daily through a rubber catheter attached to a glass funnel which is passed down the drain tube. The large calibre of this allows a free return and permits blood clot to pass out. I do not as a rule care to wash out by a catheter passed through the penis for the first week on account of the chance of the point of the instrument catching in the prostatic bed and producing bleeding, though this irrigation naturally clears the bladder out best.

At the finish of the operation a Paul's glass tube is slipped in the large calibre drain and attached at the other end is a tube leading to a bottle tied to the side of the bed. The Paul's tube is detached each time irrigation is practised.

I have not practised the water suction method of keeping the patient dry; as I mentioned the rubber tube, if properly sutured, does this for about five days.

I look on this irrigation as a very important part of the after treatment. It does not seem to matter greatly what is used, though my own preference is for dilute permanganate solution. At about this fifth day the urine begins to get rather foul; the patient is now benefited by the irri-

gation through the penis. In "dirty cases," too, the abdominal sutures start to cut in the tissues and perhaps a phosphatic incrustation forms on the raw surface. This washing is continued till the bladder gets fairly clean which usually occurs after about two or three weeks. About this time the bladder sepsis may extend up to the kidneys causing added damage to an already diseased organ and a less serious spread to the epididymis. This last complication causes a rise of temperature and some pain. I have very rarely seen suppuration set in. With an epididymitis I think it wise to stop passing a catheter through the urethra, but there is a more urgent need to keep the bladder clean which can be done by irrigation through the abdominal wound.

At this time difficulty in passing a catheter through the wound may be present and there may be little room for the return of the fluid.

The closure of the abdominal wound is of great interest to the patient and must precede any spontaneous micturition. I do not like to see this occur in less than three to three and a half weeks, because the bladder is much less easy to keep clean with the purely urethral drainage. We have to remember that the prostatic cavity is usually more extensive than the abdominal wound and is probably much more dirty. After five or six days it starts to granulate, but probably small sloughs are separating till the end of the second week.

Too early closure of the wound leads to bladder and kidney sepsis.

An ordinary prostatectomy wound should close in from three to five weeks, but an extension of this time is not unusual if the bladder is not clean.

The causes of delayed closure are sepsis, including phosphatic incrustation, and some obstruction at the internal urethral orifice. This may be due to an incomplete removal of the gland or to contraction of the curtain of mucous membrane at the entrance of the prostatic cavity. This is particularly liable to occur with small prostates and should have been clipped away at the end of the operation.

Delayed closure, too, is seen in connexion with apparently clean bladders and if it lasts beyond six weeks, it causes the patient to chafe at the waste of time. In such cases tying in a catheter for forty-eight hours which may have to be repeated, often suffices. It acts by preventing distension which separates the granulations of the abdominal sinns. Most frequently the bladder closes for a few hours and then with a cough or a little fullness during sleep starts to leak. This may go on time after time and a tied-in catheter will often finalize this. Even without this the opening ultimately closes in clean and unobstructed cases.

Spontaneous micturition is usually established with closure of the abdominal wound, but some time before this a considerable amount of urine may be passed naturally, though this attempt results in a jet of fluid passing through the suprapubic sinus. Comparatively early thirty cubic centimetres or more may be voided to the patient's delight. When it is safe to allow the patient on his feet, I insist on his attempting to urinate in the erect position, holding a pad of dressing over his wound. The object of this is not to expedite spontaneous micturition, but to empty thoroughly the lower portion of the bladder and

prostatic pouch which always contains turbid urine at this stage.

As a rule spontaneous action is satisfactorily regained and the stream is a very broad one with good projectile force, which comes as a surprise to the patient, but in a very few cases there is inability to empty the bladder thoroughly. These patients appear to be those in whom there has been prolonged overdistension and sepsis before the operation and consequent atony of the muscle. This may be stimulated with drugs, such as ergot and strychnine, but it often requires periodic passing of a catheter and washing out. The great risk is, of course, sepsis and ascending infection in this residual pool.

In my experience some of these patients are never quite satisfactory afterwards. Later on after operation the old prostatic cavity contracts down in a funnel leading from the bladder to the urethra and this becomes covered with epithelium in perhaps four months. Till this takes place there is a granulating wound and a turbidity of the bladder. In fact a bacilluria persists in these cases for some months, but usually it ultimately disappears. Later still in perhaps twelve months some kind of muscle tissue develops in the wall of the old prostatic cavity and helps to cure the dribbling which may occur at the finish of micturition.

The after results of prostatectomy are extremely satisfactory and with the exception of an occasional narrowing at the internal urethral orifice due to faulty technique as a rule are permanent. When I say this, of course, I exclude malignant disease of the prostate. Clinically patients with malignant disease are not suitable for operation, but a certain number of the easily removable glands and a greater proportion of the tough adherent ones are pronounced by the pathologist as carcinoma.

It is surprising at times to learn that a clinically innocent prostatic tumour has microscopical evidence of malignancy and still more remarkable that these patients often remain free from signs of recurrence.

The matter is very different in the fibrous adherent glands. In these extension of the infiltration narrows the passage and causes retention and often hæmorrhage of a painless type announces the commencement of further trouble.

Though the results of prostatectomy are so good, the mortality of this operation is not small. There is a remarkable difference in this respect between hospital and private patients which depends on the late stage at which many of the hospital patients come for treatment. Given a patient in whose urine is moderately sterile, in whom long obstruction has not damaged the renal function and in whom there is not much bronchitis, the risk is not a very great one.

Taking all patients that come along, I should estimate the mortality as not much less than 10% to 15%, even with the added precaution of the two-stage operation.

I regard enlarged prostate as one of the milestones many old men have to pass.

When this is safely negotiated there is in most cases an end to the bladder difficulties and rapid emptying of the viscous is easily managed.

Occasionally when the ammoniacal change in the urine persists, phosphatic stones repeatedly form and any pain and trouble with micturition some months after the operation should at once lead one to suspect this complication.

FACTORS OF SAFETY IN PROSTATECTOMY: A
REVIEW OF RECENT OPERATIVE RESULTS.

By S. HARRY HARRIS, M.D., CH.M. (Sydney),
*Honorary Urologist to the Lewisham Hospital; Honorary
Urologist, South Sydney Women's Hospital.*

During the ten-year period from September 1, 1913, to August 31, 1923, two hundred and fifty-three operations for removal of the prostate have been performed by me with ten deaths, a mortality rate of approximately 3.9%.

The mortality and more particularly the morbidity rate have so far progressively improved that I think in presenting to you the opening paper, the time at my disposal will be most profitably employed in a review of the sixty-five patients operated upon during the past eighteen months of the period. The other cases, with the exception of one short series, have all been recorded from time to time in THE MEDICAL JOURNAL OF AUSTRALIA.

In the present series of sixty-five cases there was one operative death, a mortality rate of approximately 1.5%.

Analysis of Cases.

Age.

The average age of the sixty-five patients was sixty-eight years, the oldest was eighty-four and the youngest fifty-one.

Residual Urine.

Seventeen of the patients had complete retention of urine on admission to hospital; ten others had overflow incontinence. Two had had supra-pubic cystotomy performed. Of the remaining thirty-six, ten had residual urine amounting to 120 cubic centimetres (four ounces) or more and twenty-six had residual urine less than 120 cubic centimetres.

Of the above three had been unsuccessfully operated on elsewhere for removal of the prostate, two by the supra-pubic and one by the perineal route, the latter having a perineal urinary fistula.

Haematuria.

Haematuria had occurred at some time in fourteen of the patients, approximately 21%; one, on admission, was bleeding profusely from the urethra without other symptoms, though no instrumentation had been practised. One patient was admitted with the bladder distended to the umbilicus with clotted blood and was submitted to immediate preliminary cystotomy; this was the only patient of the series so treated.

Haematuria occurred in the simple and malignant cases in about equal proportions.

Carcinoma of the Prostate.

Definite palpable carcinoma was present in eleven patients (later confirmed at operation); two, in whom malignancy was not suspected, were found at operation to have definitely malignant prostatic growths. The post-operative course of these thirteen malignant cases varied not at all from that of the non-malignant. And in no case has there been a later opening up of the supra-pubic fistula. All, except one who died after seven months, are at present alive and well.

Only those prostates were regularly submitted to microscopic examination in which naked eye appearances were suggestive of malignancy and in which no definite plane

of cleavage existed, especially in the posterior part of the growth.

Cancer of the prostate has its origin almost without exception in the posterior lobe (that is the part of the prostate below the ejaculatory ducts) and it involves the rest of the prostate by local infiltration. The rest of the prostate is often the seat of a simple adenomatous growth; and the ease or difficulty of the enucleation depends almost entirely on the extent of the malignant infiltration.

Calculi.

Calculi were present in twelve patients, approximately 18%. All recovered without special incident.

Diverticulum of the Bladder.

This was present in marked degree in only one and was deferred for future operation, if necessary, as the patient's condition did not warrant any extension of operation.

Nodular Carcinoma of the Fundus of the Bladder.

Nodular carcinoma of the fundus of the bladder was present in one patient and was widely resected at the time of operation, with recovery. There has been no visible recurrence to date, just eighteen months after operation.

Papilloma of the Bladder.

Papilloma of the bladder did not occur in association with the prostatic growth in any of this series.

Incidental Lesions.

Incidental lesions were too numerous to relate. Suffice it to say that prostatectomy was refused in only two non-malignant cases during the currency of the present series, in which, after admission to hospital, the renal function was proved sufficiently good to admit of prostatectomy. Of these two patients one was the subject of auricular fibrillation with dyspnoea on the slightest exertion. A permanent cystotomy was performed in March of this year; there has been an extraordinary improvement in the general condition and prostatectomy will probably be undertaken at an early date. The remaining patient was the subject of *diabetes mellitus* with a blood-sugar content while fasting of 1.9%. Treatment with the "Insulin" supplied in August of this year had no effect and his operation was deferred pending the supply of active "Insulin."

Cystoscopic Examination.

This was performed in ten cases in this series and then only when it was deemed necessary for purposes of diagnosis. Where preliminary renal decompression was indicated, this was performed prior to the cystoscopy.

Post-operative Mortality.

As stated above there was one fatal case in the series. This patient, Angus M., *aetatis* sixty-seven years, was operated on in March of this year after twenty-one days catheter drainage. On admission there was a large amount of residual urine with very defective renal function and a myocarditis resulting from an attack of pneumonic influenza three months previously. He improved greatly under treatment and seemed a "fair risk" at the time of operation, which was devoid of special incident. He had some secondary hæmorrhage thirty-six hours later, for which the prostatic cavity was packed with gauze. Immediate progress was apparently satisfactory, but he gradually sank and died of circulatory failure seven days later.

Post-operative Results.

In a previous paper I recorded in detail the late results in a larger series of cases. The present paper is concerned only with the results of the past eighteen months. These will be dealt with under the following headings:

Immediate Post-Operative Complications.

- (1) Immediate post-operative complications including (a) shock, (b) hæmorrhage, (c) uræmia, (d) sepsis, (e) epididymitis, (f) gastro-intestinal complications.
- (2) Onset of micturition.
- (3) Persistence or recurrence of obstruction.

Shock.

In no case in the series had restorative measures of any kind to be adopted to combat post-operative shock.

Hæmorrhage.

Hæmorrhage demanding active treatment occurred in two cases on the second and tenth days respectively. In the former case the prostatic cavity was packed with gauze (*vide supra*). The latter patient was treated by reopening the supra-pubic sinus (which had closed on the eighth day), washing out the clots and replacing the drainage tube for two days; complete recovery ensued.

Uræmia.

A patient, *aetatis* eighty-one years, was submitted to operation in January, 1923, despite a very faint indigo-carminic secretion, as it was thought that his renal function, though much below par, was just within operative limits. It was not surprising, therefore, that he developed complete anuria for thirty-six hours after operation and hiccup for seven days. He eventually made a complete recovery. This was the only patient in the series in whom there developed uræmic manifestations of any kind whatever.

Sepsis.

There was in the series no evident case of post-operative urinary sepsis, of infection of the prevesical space or of wound infection.

Epididymitis occurred in eight of the patients, that is, slightly more than 12%. It occurred twice during the period of preliminary catheter drainage, four times in the second week of convalescence, twice after discharge from hospital.

Careful suspension of the scrotum and the most rigid aseptic and antiseptic precautions, particularly so far as the urethra and penis are concerned before, during and after operation have done much to reduce the incidence of this annoying complication.

Gastro-intestinal Complications.

Abdominal distension and troublesome vomiting, so often annoying complications after any abdominal operation, were noticeably absent in the cases of this series due largely, I venture to think, to the improved type of operation employed.

II. Onset of Micturition.

Fifty-two of the sixty-five patients, *id est* 80%, passed urine spontaneously *per urethram* before the fourteenth day after operation, the majority between the eighth and twelfth days, the fistula usually being completely closed from three to seven days later.

In nine of the remaining thirteen patients natural micturition, though delayed, was well established before the

eighteenth day, either without interference or following daily bladder irrigation by catheter *per urethram*.

The remaining four patients, who failed to pass urine *per urethram* by the eighteenth day, were treated by retention catheter for three to five days. Complete closure of the fistula was the result in all except one case, which will be the subject of immediate reference.

III. Persistence or Recurrence of Obstruction.

Complete inability to start the natural flow occurred in one case. At operation a very early trilobed enlargement of the prostate had been removed, leaving a very sharply defined, but not thickened sphincter region. With the electrically lighted detractor in position a very good view was obtained. The ledge was bisected deeply backwards with scissors, the ends retracting sharply. Convalescence was uneventful, but natural micturition could not be induced by retained catheter and after the first attempt neither catheter nor sound could be passed beyond the prostatic cavity. The bladder was therefore reopened through the old incision on the twenty-sixth day after operation when with a sound passed *per urethram* it was seen that the bladder neck was occluded by a tent-like membrane. This was cut away and a catheter tied in the urethra for five days. Natural micturition began two days later and the patient has since remained free of trouble. It is evident that a wide wedge should have been excised at the first operation instead of a simple section of the ledge.

Some recurrence or persistence of difficulty in micturition was present in three other patients. Of these one had cancer of the posterior lobe associated with adenoma of the lateral lobes. The lateral lobes were enucleated easily, but there was no plane of cleavage behind; sufficient growth was left adherent to the fascia of Denonvilliers to cause a definite projection into the prostatic part of the urethra. This was readily removed *per urethram* with Young's prostatic punch with complete relief. This was one of the cases mentioned above under Section II, in which natural micturition had been induced by the employment of the retention catheter for three days.

The second patient had left hospital in good condition, but returned six weeks later with some difficulty of micturition. He had had a large trilobed prostate removed leaving a widely gaping, clean-cut vesical neck. Cystoscopic examination revealed a well marked ledge formation posteriorly. This was removed forthwith *per urethram* by Young's punch with complete relief. Microscopic examination of the portion excised disclosed chiefly muscular tissue—evidently an attempt at reformation of the *sphincter vesicae*.

The last of the three patients developed obstruction within five weeks of operation. Cystoscopic examination found a small stone in the bladder which was immediately evacuated.

Treatment.

In patients suffering from prostatism of advanced degree, perhaps more than in any other type of case, the institution of a thorough-going preliminary medical examination and any indicated treatment is a *sine qua non* of success.

Preliminary treatment directed towards improvement of renal function was carried out whenever possible by retained catheter in all cases with a residual urine of 120 cubic centimetres (four ounces) or more. This was con-

tinued for at least seven days and until such time as an intramuscular injection of four cubic centimetres of 4% solution of indigo-carmin gave a good blue coloration to the urine within thirty minutes. Thirty-six of the patients were so treated, the average duration of the treatment being ten to twelve days. Various factors will often determine a much longer period of treatment, though twenty-one days was not exceeded in any case of this series which came to operation.

Of the remaining twenty-nine patients of the series twenty-one, including two who were admitted with cystotomies, were in good general condition, with a normal indigo-carmin secretion and a residual urine of less than 120 cubic centimetres (four ounces). They were all submitted to prostatectomy without catheter preparation after a rest of a day or two in hospital.

Seven other patients in a similar condition but with more or less irritable, infected bladders were treated for several days by intermittent catheterization and bladder irrigation with nitrate of silver (1:3,000) until sufficiently clean.

The remaining patient of the series was admitted to hospital with complete retention, the bladder being distended with blood-clot which could not be emptied by catheter. Immediate cystotomy was performed and prostatectomy twenty-seven days later.

In all cases where the bladder was sufficiently distended to form a palpable abdominal tumour, it was the invariable rule that not more than 120 to 240 cubic centimetres (four to eight ounces) per hour should be allowed to run off, the catheter being clamped in the intervals. Generally twenty-four to thirty-six hours sufficed for complete emptying.

In all cases forced ingestion of fluid formed an essential part of the treatment, more particularly in those patients with a large amount of residual urine.

Sodium benzoate in one gramme (fifteen grain) doses three times a day was exhibited in all cases and hexamin in 0.3 to one gramme (five to fifteen grain) doses three or four times a day when tolerated and the urine was acid.

Confinement to bed was discouraged, the majority of patients being out of bed during practically the entire period of preliminary treatment.

Operative Technique.

Suprapubic prostatectomy, under intrapharyngeal ether anaesthesia, was carried out in practically all the cases of this series, Squier's method of enucleation, which leaves the *veru montanum* and ejaculatory ducts intact, being the procedure of election.

The bladder is washed out with 1:3,000 solution of *argenti nitratis*, emptied as completely as possible and the catheter removed immediately before the patient is brought to the operating theatre.

The patient is placed in a low Trendelenburg position, and a transverse suprapubic incision, 3.75 centimetres (1½ inches) in length, made through skin and fat. The aponeurosis is slit vertically in the mid-line for a similar

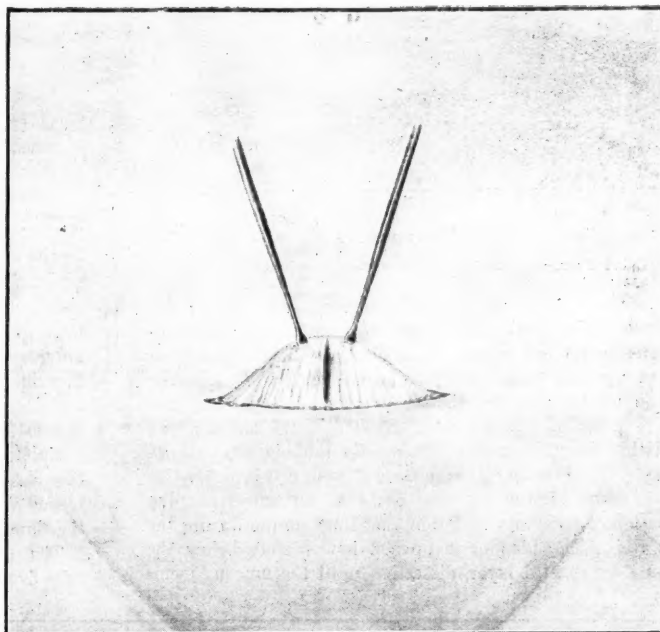


FIGURE I.
The Bladder drawn up into the Incision.

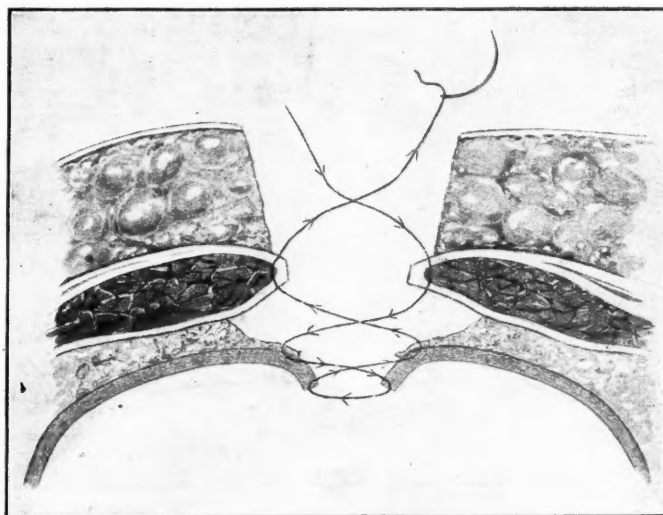


FIGURE II.
Extended Figure of Eight Suture Inserted.

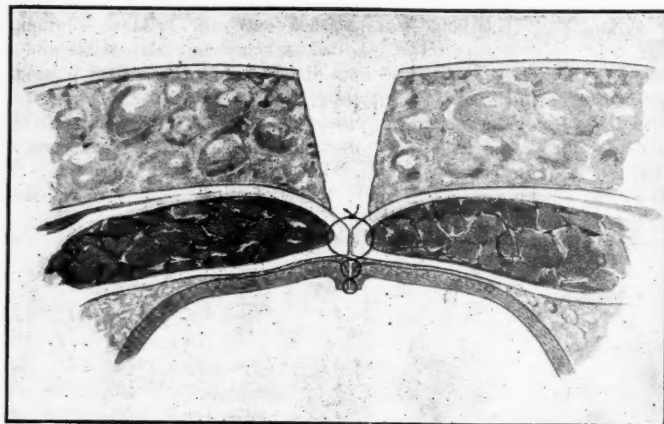


FIGURE III.

Extended Figure of Eight Suture Tied, showing obliteration of dead spaces.

distance. The recti muscles are separated and the transversalis fascia cut in the same direction. The bladder is picked up with tissue forceps and the peritoneal reflection pushed up beyond the highest point of the bladder, successive pairs of forceps being applied to the bladder wall until this point is reached, when only the highest pair remains. The bladder is now drawn well up into the incision (see Figure I.) and acts as an effective plug against any residuum of lotion that may escape during the next step. The bladder is opened immediately below the forceps by careful layer dissection until the mucous mem-

brane is reached. This is picked up with dissecting forceps and nicked to an extent sufficient only to allow the immediate insertion of the nozzle of a Gwathmey's electric suction tube. When the bladder is completely empty, the suction tube is removed and the incision lengthened until two fingers are readily admitted. Careful digital exploration of the bladder is made and calculi, if present, are removed. Bimanual enucleation and removal of the prostate are then proceeded with. With proper arrangement of sheets and three gloves on the left hand which are successively removed when soiled, no contamination of the operative field takes place even after manipulation entailing removal and reinsertion of the fingers in the rectum. The bladder neck is now reviewed and any indicated "trimming"

performed. After bleeding has received any necessary attention, a single extended figure of eight suture of No. 3 plain catgut is loosely inserted (as shown in Figure II.), embracing the cut edges of the bladder, the fibrous and muscular layers of the bladder and recti muscles and aponeurosis. The special glass bladder drainage tube is then inserted and the suture drawn tight and tied, coapting and inverting the bladder edges and obliterating all dead spaces (see Figures III. and IV.). The operation is now complete, the tube comfortably filling the abdominal wound (see figure V.), though occasionally a Michel clip may be placed with advantage in the skin on one or other side of the flange of the drainage tube.

The dressings are now applied and the glass drainage tube fixed firmly in position by zinc oxide strapping placed outside the dressings in such a way that the glass connecting tube may, if necessary for the removal of clots, be disconnected from the rubber piece on top of the bladder drainage tube without disturbing the dressings.

When special measures for operative control of hæmorrhage were necessary, which was exceptional, bimanual compression sufficed in all except four cases. In these iodoform gauze was packed into the prostatic cavity around the end of a rubber catheter passed *per urethram*, both being removed twenty-four to forty-eight hours later.

It is very important, both for immediate hæmostasis and to insure satisfactory after-results that a complete clearance be made of the prostatic cavity and bladder neck. I have elsewhere detailed the precautions taken at this stage of the operation (THE MEDICAL JOURNAL OF AUSTRALIA, October 7, 1922). Important though they be, time does not permit their further consideration at this juncture, beyond stating that more extended experience suggests that where it is deemed necessary to divide the sphincter region posteriorly in the mid-line with a view to prevention of post-operative ledge formation, it is wise to cut out a wide wedge rather than make a simple section.

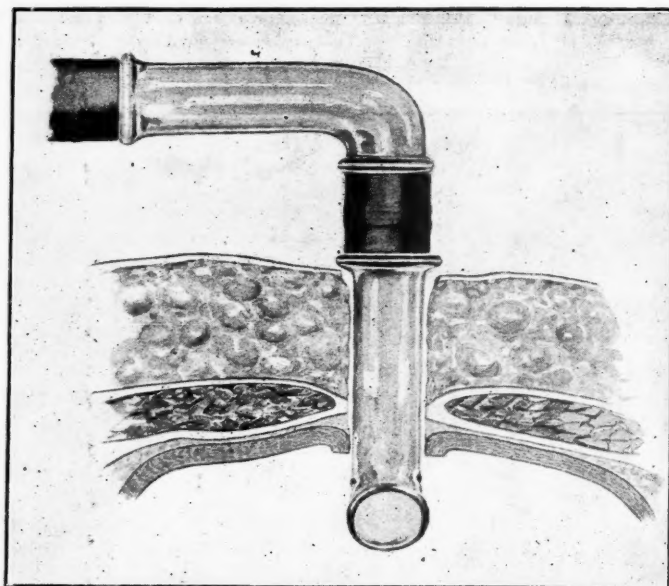


FIGURE IV.

Showing the Glass Bladder Drainage Tube in Position at completion of the operation.

The whole of the bladder base can be thoroughly inspected by means of my specially constructed, electrically lighted modification of Walker's retractor. With the aid of special scissors and forceps any necessary procedure incidental to the prostatectomy can be readily performed through the restricted incision described. This heals with a linear scar and leaves to all intents and purposes a normal abdominal wall.

The very long incisions and wide retraction advocated and practised by some surgeons with the object of bringing the operative field into open daylight, I have not found necessary. In fact, while they permit of no operative procedure on the prostatic environs which cannot be accomplished readily as described above, they carry very special disadvantages of their own, such as greater liability to wound infection, post-operative pain and vomiting and hernia formation.

After-treatment.

Three hundred cubic centimetres (half a pint) of salt solution are given *per rectum* immediately the patient returns to bed and none thereafter and an Alexander bandage is fixed in position to suspend the scrotum. A hypodermic injection of 0.01 gramme (1/6 grain) of morphine is given as the patient is regaining consciousness and repeated as required.

The patient is propped up in bed as soon as complete consciousness is restored.

On the morning of the fourth day after operation fifteen to thirty cubic centimetres (a half to one ounce) of castor oil is given by mouth and 180 cubic centimetres (six ounces) of warm olive oil *per rectum*.

The abdominal dressings are changed, if necessary, at the end of twenty-four hours. After this they rarely have to be touched until the bladder drainage tube is removed about the sixth day.

Patients are generally out of bed on the tenth day.

Hexamin and sodium benzoate are administered as before operation, but not until all bleeding has ceased.

No bladder irrigation of any kind is employed, at any rate during the first fortnight. After this, if the urine is very dirty, catheter irrigation of the bladder with 1:3,000 solution of nitrate of silver is practised for a few days.

Conclusions.

It is a fact which, *ceteris paribus*, admits of no dispute, that the sooner a patient with prostatic enlargement submits to operation, the safer the operation and the better the result.

It must be realized that the disease is a progressive one and sooner or later tends to disaster. In expert hands and in early cases the mortality should be little, if at all, greater than that of the interim operation for the removal of a diseased appendix.

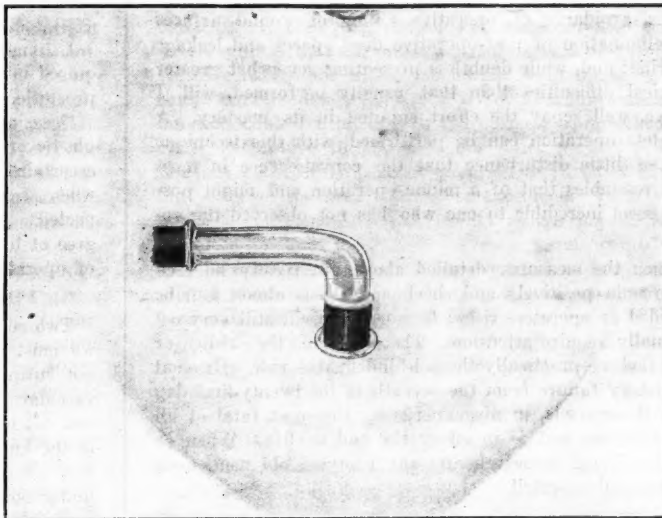


FIGURE V.

The Operation Completed, the Glass Drainage Tube comfortably filling the incision.

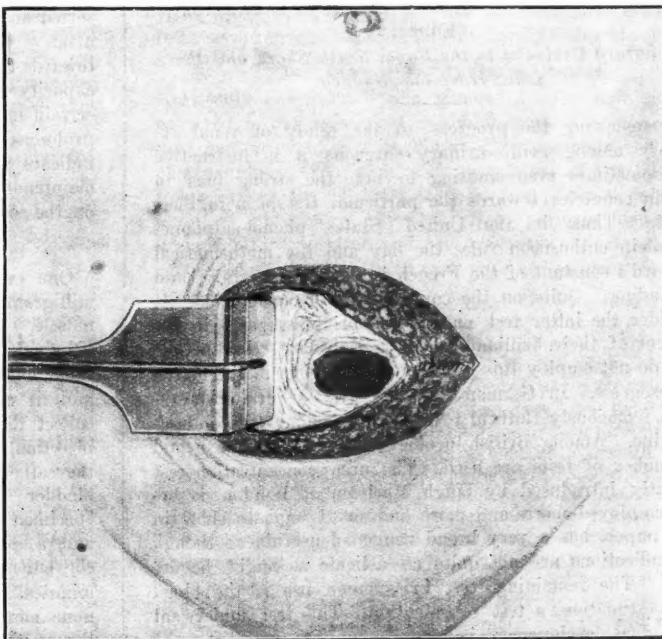


FIGURE VI.

View of Bladder Neck after Prostatectomy. The field of operation is shown relatively much enlarged for purposes of demonstration.

If medical practitioners and the public could only be fully seized of these facts, it would remove much of the misery and distress to which these old men submit, rather than face what they and too often their medical advisers consider a desperate remedy.

The operation described presents, I venture to think, several novel features, the details of which have been designed with a view to creating a minimum disturbance of

tissues, avoidance of operative soiling of wound-surfaces and elimination of post-operative dead spaces and leakage of urine: and, while doubtless presenting somewhat greater technical difficulties than that usually performed, will, I believe, well repay the effort entailed in its mastery. A complete operation can be performed with this technique with so little disturbance that the convalescence in most cases resembles that of a minor operation and might possibly seem incredible to one who has not observed the results.

When the measures detailed above are rigidly adhered to, uræmia positively and shock and sepsis almost can be excluded as operative risks; hæmorrhage will still very occasionally require attention. There remains the cardiac or vital factor—practically the sole undefinable risk. Gradual circulatory failure from the seventh to the twenty-first day when it occurs is, in my experience, the most fatal of all complications and is in effect the end of life. When or whether it will supervene in any of these old men, none can certainly foretell.

RENAL INSUFFICIENCY. ITS IMPORTANCE IN GENITO-URINARY SURGERY.

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In reviewing the progress of the study of renal efficiency among genito-urinary surgeons it is instructive and sometimes even amusing to note the strong bias in certain countries towards the particular test born in their midst. Thus, in the United States phenol-sulphone-phthalein enthusiasm rules the day and the mathematical Ambard's constant of the French is dismissed as false and misleading. Quite on the contrary, the French urologists consider the latter test one of the brightest gems in the diadem of their brilliant school and declare that people who do not employ this test, are still lagging in the march of progress. In Germany the majority of urologists remain tenaciously faithful to their own colour test, indigo-carmin. Among British urologists there is no fetish and a number of tests are used. The urea concentration test recently introduced by Hugh Maclean, of London, is being employed more and more and, as I hope to show in this paper, has a very broad range of usefulness though its indications are not quite as delicate as might be desired. The remaining test in common use is the blood urea estimation, a test of retention. This test underwent a gradual development in several countries and at present is valued by all.

This paper is based on the study of renal efficiency tests in one hundred and seventy-two personal cases. With the exception of a very few these patients were operated upon and the value of the tests checked by observation of the patients from the point of view of urinary secretion after the operation. Of these patients one hundred and three suffered from lower urinary tract disease (prostate, bladder neck, bladder cavity or urethra) and sixty-nine from upper tract disease (kidney or ureter).

TOTAL RENAL EFFICIENCY.

Estimation of the total renal efficiency is usually required in cases of obstruction at the bladder neck, notably prostatic.

Occasionally in urethral obstruction and calculous, neoplastic or diverticular disease of the bladder it is well to ascertain the renal state before operation, particularly when ascending infection or back-pressure effects are suspected. As a rule, however, in the latter groups the degree of local sepsis sways the decision as to time and type of operation.

BLADDER NECK OBSTRUCTION.

Two considerations are all important. In the first place we must not be over-swayed by renal tests. They should not entirely decide the plan of campaign. The cardiovascular, respiratory and alimentary systems need study and often treatment and should be paid as much attention as the kidneys. In the second place it must be remembered that functional tests made soon after the patient comes under observation do not indicate for certain how he will react to the shock of an operation. In all but the most patently good "risks" it is wise to decompress the kidneys by inlying catheter drainage and test the renal efficiency at regular intervals during this period. It is my custom to perform the first tests as soon as the catheter is inserted and to repeat them every three or four days thereafter. With catheter decompression it is observed that towards the end of the first week a diminution of the renal capacity occurs in the great majority of patients, but in a certain number this phase of depression is delayed until or prolonged into the second week. It is not until the tests indicate a reactionary rise in efficiency and moreover a maintenance of the reactionary level that operative safety on the score of the kidneys is assured.

The Phenol-Sulphone-Phthalein Test.

One cubic centimetre of dye solution (containing six milligrammes of the dye substance) is injected into a muscle. I prefer the deltoid and make the injection with a hypodermic syringe for the sake of accuracy, as such a small amount is injected. A nurse can give the injection and, if a catheter is already inlying, she has simply to collect the urine for one hour and ten minutes after the injection. There is no chance of technical error provided the catheter is draining freely and the nurse empties the bladder completely by pressing suprapubically. The specimen is awaiting the surgeon when he visits the patient and a simple colorimetric estimation performed at his convenience will give him the result in two or three minutes. No test could be simpler or more convenient and none more free from possible technical error. Moreover, the results are quite unaffected by the amount of blood urea or blood chlorides or by diuresis or protein intake.

Unfortunately many people have discouraged surgeons from using the test by alleging a difficulty in the colorimetric estimation. There is no difficulty in this regard and, far from a colorimeter being necessary, I am convinced that it is actually a disadvantage. A simple "home-made" instrument consisting of two test tubes of equal calibre, one plain and the other graduated into half a dozen equal divisions of two or three cubic centimetres each is all that is necessary (see Figure I.).

The essential part of the test is the dilution of a standard solution of phthalein (made up with water alone) until it matches exactly the coloured urine drawn from the patient. Should the urine contain much urinary pigment, the yellow tone of the latter will convert the pink of the phthalein into a light orange tint, so that the tones of the standard solution and the urine under test cannot properly be matched. By the simple means of using urine as well as water to dilute the standard solution, perfect matching will be obtained. This is impossible if a colorimetric instrument is used.

The standard solution is made up by dissolving one cubic centimetre of dye (six milligrammes) in a given amount of water (say half a litre). By adding strong caustic soda the brilliant magenta colour of this dilution of the dye is brought out. This solution is called a 100% solution, since it contains the whole of the cubic centimetre; it can be kept in stock.

The sixty to ninety cubic centimetres of urine drawn from the patient are diluted to the same amount (half a litre) and the colour brought out with alkali. The plain test tube is filled with this diluted urine. Standard solution is poured into the graduated tube only up to the first mark. This solution with its deep magenta colour is now diluted with water and a sufficient relative amount of any urine that is handy till it matches the light pinkish-orange shade of the specimen in the plain tube. The figure 100, divided by the reading at the level of the fluid in the graduated tube, gives the result. This is the percentage of dye excreted by the kidneys in one hour, the extra ten minutes being a rough allowance for the average time the dye takes to make its appearance in the urine.

The normal total excretion in the first hour and ten minutes is between 40% and 60% of the amount of dye injected. Moderate renal damage is indicated by a 20% to 30% output; below 10% shows extreme damage.

The Urea Concentration Test.

This test, like the blood urea estimation, is best applied as a routine before breakfast to avoid fallacies from protein intake. Fifteen grammes of urea dissolved in one hundred cubic centimetres of water and flavoured with a few drops of tincture of orange are given at 6 a.m.. A catheter is supposed to be inlying. The first hour's urine is discarded and that of the second hour or the third hour collected and sent for estimation of the urea percentage. A note is kept of the amount of urine excreted during the hour, for in the presence of more than seventy-five cubic centimetres (indicating diuresis) a low urea percentage has not necessarily an ominous significance. It is very important that the patient should take nothing, either solid or fluid, until the final collection is made.

In health the minimum concentration during the second and third hours should be 2.5%, but no serious significance can necessarily be attached to readings down to 2%. Moderately severe damage is indicated by a concentration of 1.5%, severe damage by 1% and under.

Blood Urea Test.

As the performance of the blood urea test lies within the province of the bio-chemist, I shall not describe its technique. A few other points, however, deserve mention. To compare results properly the blood should always be

drawn at a routine time, preferably before breakfast to avoid interference from protein and water intake. It must be recognized that the normal urea content of the blood varies considerably within somewhat wide limits. Thus some workers describe twenty to forty milligrammes per hundred cubic centimetres as the normal, while others declare that twelve to fifteen is the strict normal. Hugh Maclean has recently drawn attention to effect of advancing years on the urea content of the blood. In a young adult he considers fifteen to twenty as the normal limits, while in an individual over seventy years up to sixty milligrammes per hundred cubic centimetres may be considered normal. Therefore, to take the extremes of adult years, danger signs would definitely commence at about thirty to forty milligrammes in a young adult, but not until eighty or ninety milligrammes were reached in an old person.

Practical Results.

Either the phthalein or the urea concentration test was performed on several occasions in each of sixty-nine patients with enlarged prostate on whom later suprapubic prostatectomy was performed. In thirty-five both tests were applied. In ten the blood urea test was performed in addition. In three patients with median vesical bar in whom open suprapubic operation was performed, similar tests were used. Finally in thirty-four patients with diverse diseases of the urethra and bladder, total efficiency tests were required to complete the preliminary study.

Typical Cases of Severe Renal Damage.

As only one death (from general debility and sepsis) occurred in this series and in this instance a *post mortem* examination could not be obtained to ascertain the state of the kidneys, I publish, with permission of the late Sir Peter Freyer, the efficiency tests in two patients operated upon at St. Peter's Hospital. Both patients died from uræmia after operation and the drawings reproduced here of one of the kidneys from each man are instructive.

The first patient was a male, aged fifty-five years, with enlarged prostate. The phthalein output was only 6% in the first hour and ten minutes (normal 40%). He survived a preliminary cystostomy. On the sixth day the phthalein was 8%. Prostate enucleated was performed on the seventh day. Death occurred two days later from renal failure. The cause was undoubtedly insufficient preliminary drainage. At the *post mortem* examination greatly damaged kidneys were discovered (see Figure II.).

The second patient was a male, aged sixty-four years, with an enlarged prostate. The phthalein output was even less than in the preceding case, being only 5%. This patient died after the preliminary cystostomy. Cystostomy is a dangerous preliminary in cases of severe renal damage. In this case the urea concentration test (0.6%) agreed with the phthalein, but the more delicate and therefore more definite indication of danger given by the phthalein test is clearly evident. Figure III. displays the state of one of the kidneys removed *post mortem*. In both of these patients the renal destruction was approximately equal on each side.

Effects of Preliminary Drainage on the Tests. Cystostomy.

In this series only five patients were prepared by cystostomy. A typical example of fluctuation in both the phthalein and the urea tests showing the phase of renal

depression during cystostomy drainage, is the following.

The patient was a male, aged sixty-three years, with nine months prostatic history.

Day of Drainage	Phthalein Test	Urea Concentration Test
On Admission	20%	1.75%
Third	16%	1.4%
Seventh	33%	2.5%

Prostatectomy was performed on the ninth day of drainage. There was good convalescence.

Catheter Preparation.

The great majority of my patients with bladder neck obstruction were prepared in this way.

A good example of the typical course followed during catheter drainage is the following.

A well preserved man of seventy-five years had moderately enlarged prostate.

Day of Drainage	Urea Concentration Test
On admission	2.4%
Fourth	1.6%
Eighth	2.1%
Twelfth	2.9%

On the fourteenth day of drainage prostatectomy was performed. The patient had a quick and good convalescence. Note that recovery from the phase of depression was not complete until after the eighth day.

Comparison of Phthalein and Urea Results.

In thirty-five patients both tests were applied. There was substantial agreement between the two tests in thirty-two.

The results at variance were:

Patient	Phthalein Test	Urea Test	Remarks
1	25%	2.5%	Explained by incomplete catheter drainage with phthalein test.
2	28%	2.4%	The phthalein test was repeated in both patients with the same result; the cause is unknown.
3	19%	2.1%	

All three patients did well after a one-stage prostatectomy, which seems to indicate that we may be guided by the more optimistic test, provided the more pessimistic test is not exceedingly low.

Comparison of the Urea Concentration and the Blood Urea Tests.

The blood urea test was only applied to ten patients in this series and in all as a check on the urea concentration test. In all except one the two tests agreed. The results in the one were as follows:

Day of Drainage	Urea Concentration Test	Blood Urea
On admission	1.6%	35 milligrammes per 100 c.cm.
Seventh	1.6%	23 milligrammes per 100 c.cm.

Here the result of the urea concentration test was only moderate, while the blood urea was quite within the normal (patient aged sixty-five). One-stage prostatectomy on the tenth day was followed by a quick recovery. The indication of the more optimistic test was successfully followed. I have not yet met with the reverse state of affairs, a good urea concentration test with a bad blood urea result, but Thomson Walker has recently stated that in such a case the more optimistic test may be followed.

SEPARATE RENAL EFFICIENCY.

As with disease of the lower tract, the phenol-sulphone-phthalein test is in itself the pre-eminent dye test of renal excretory capacity. It has, however, several important manipulative disadvantages when employed with the ureteric catheter, so that I have come to reserve it for the extra study of special cases and in its place use indigo-carmin. In addition, every patient for cystoscopy is given fifteen grammes of urea by mouth one hour before the examination. Any specimen, however small, drawn from either kidney during the second or third hours after the administration of the urea is suitable for the purposes of the urea concentration test.

Indigo-Carmine.

I inject ten cubic centimetres of a saturated (0.6%) solution of indigo-carmin intravenously just before the introduction of the cystoscope. The dye is first excreted as pale green, then a darker green and finally pale blue leading up to deep blue. As a rule a blue efflux is seen at the ureteric orifice in one to four minutes with healthy kidneys and should not be delayed until more than seven or eight minutes, except with a general anæsthetic, when the appearance-time is anything up to twelve minutes. In the latter case I inject the indigo just before the anæsthetic is administered.

Even before the catheters are introduced, some indication of the relative kidney efficiencies is obtained by chromocystoscopy. Should ureteric obstruction, catheter-blockage, reflex inhibition or other cause prevent collection of part or all of the urine from one or both kidneys, the information gleaned from observation of the coloured efflux still remains. Moreover, it is surprising to note how very often part or all of the urine escapes alongside a ureteric catheter into the bladder. As a rule the channels of a double-catheterising cystoscope accommodate catheters only up to No. 6 (French) and extra-catheter leakage is not at all uncommon even with this size. Even a slight degree of such leakage renders the phthalein test useless.

Practical Results.

The present study includes sixty-nine patients with upper tract disease in whom tests of excretion were applied. In fifty-two patients indigo-carmin was used, in forty-two

ILLUSTRATIONS TO PAPER OF DR. R. J. SILVERTON (See Pages 106-9).

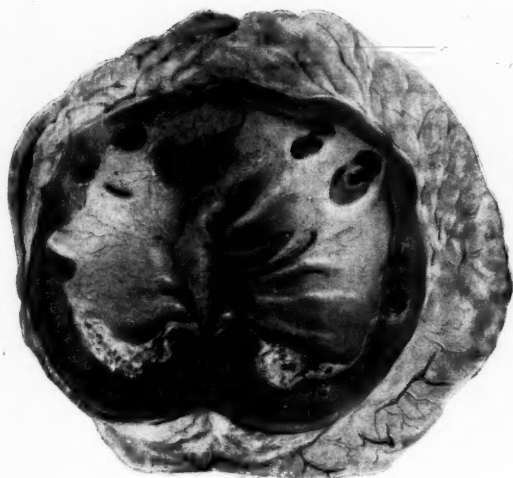


FIGURE II.

One kidney from a fatal prostatectomy case. Death from uraemia. The phthalein output was only 8 per cent. in one hour (normal 40 per cent.).
Note the hollowing out of the organ with destruction of the pyramids and thinning of the cortex.

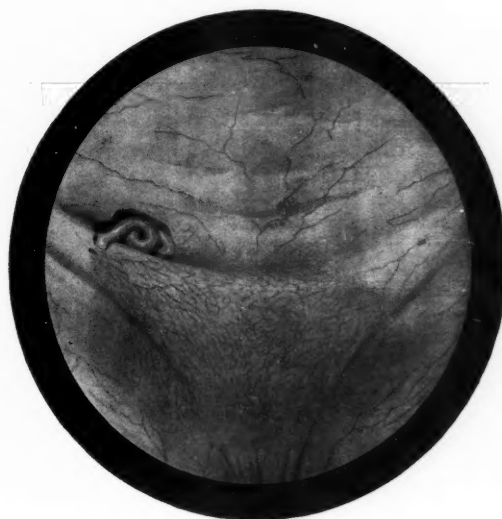


FIGURE IV.

Composite cystoscopic view showing both ureteric orifices. Putty-like pus from right ureter with complete destruction of that kidney. Phthalein output from the left kidney was double the normal.

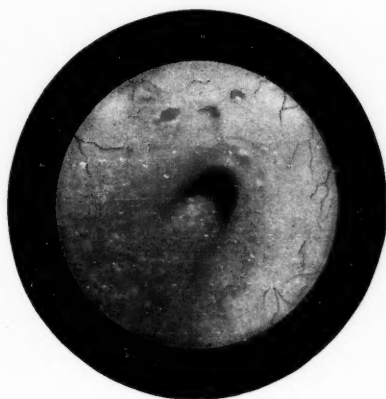


FIGURE V.

Typical tuberculous ureteric orifice, dragged out and rigid. Nearby are three tiny ulcers and two tubercles. Urea concentration test of other side was 2.1 per cent.

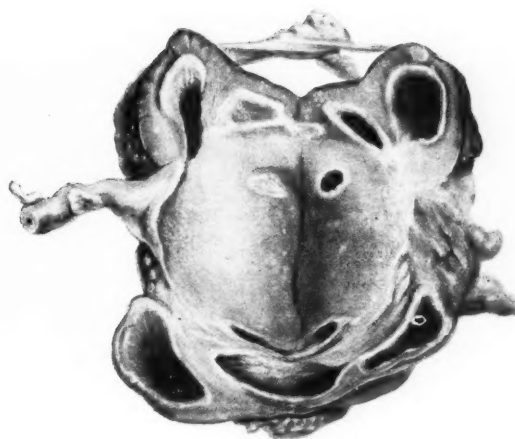


FIGURE VI.

Tubercular kidney corresponding to the orifice shown in Figure V.

ILLUSTRATIONS TO PAPER OF DR. R. J. SILVERTON (See Pages 106-9).

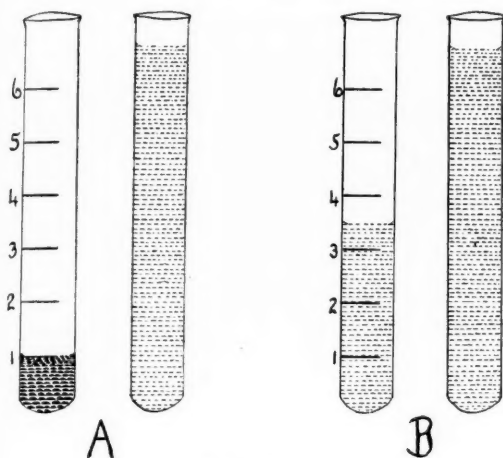


FIGURE I.

In A the 100 per cent. standard solution is poured into the calibrated tube up to mark 1. The plain tube is filled with the diluted urine under test. In B the tints match when the standard solution is diluted to the mark 3.5. The result is 100/3.5, i.e. 28.5 per cent.



FIGURE III.

One kidney from a fatal preliminary cystostomy case. Urea concentration test, 0.6 per cent. (normal 2.5 per cent.). Phthalein only 5 per cent. (normal 40 per cent.).

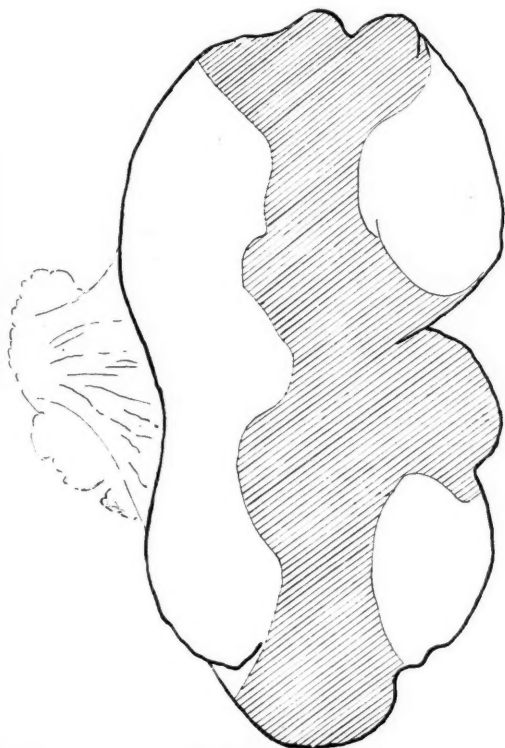


FIGURE VII.

Approximately one half of this kidney was a gross old fibrous infarct depressed below the general surface. The fibrous area is shaded. The phthalein output from this organ was one half of the normal.

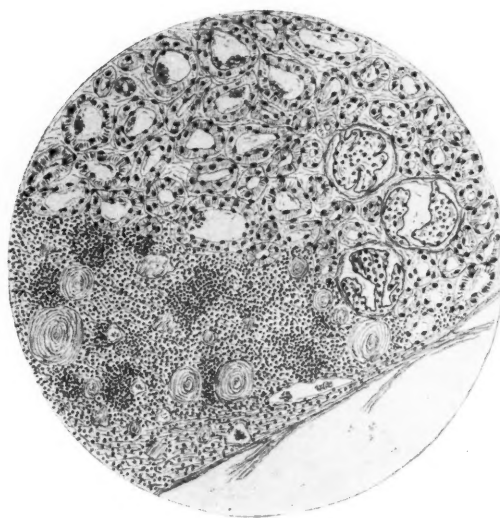


FIGURE VIII.

Microscopic drawing of the junction between fibrous infarct and healthy tissue from the kidney depicted in Figure VII.

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the urea concentration was measured and in thirteen the phthalein test was applied. In thirty-eight patients indigo and urea tests were applied together.

Pyonephrosis.

In the rare cases where one desires to use the phthalein test in conjunction with the ureteric catheter, it should be injected intravenously. The time of appearance is noted by letting the urine drop into alkali and waiting for a pink tinge. A ten minutes collection of the urine will now suffice. One healthy kidney should excrete 10% of the dye in the first ten minutes. A man, aged forty-seven years, with complete destruction of the right kidney (for the cystoscopic view see Figure IV.) excreted 25% of the phthalein from the left kidney in ten minutes. This was well over double the normal, and indicated complete compensatory hypertrophy.

Pyelonephritis.

An illustration is the case of a medical student, aged twenty-one years, with blood and pus in the urine and bladder irritation as the sole symptom.

Urine from Kidney	Appearance of Indigo	Colour of Indigo	Urea concentration Test
Right	4 minutes	Deep blue	3.4%
Left	7 minutes	Medium green	2.1%

The specimen from the left kidney contained pus cells and *Staphylococcus albus*. Nothing abnormal was detected in the urine from the right kidney. General medical measures and autogenous vaccines brought about a quick cure.

Renal Calculus.

In an interesting case of a young girl with renal pain on the left side only, the radiogram unexpectedly showed a shadow on the right side (renal pelvis). As there were no pus cells in the urine, I was dependent entirely on the functional tests for confirmation of the radiogram. Both the indigo and the urea tests showed definite deficiency on the right side.

Renal Tuberculosis.

Figure V. shows the cystoscopic view in a young man, aged 22, who was suffering from ulcero-cavernous tuberculosis of the left kidney. Only the right side was catheterized. Here, pus cells were absent and the urea concentration was 2.1%. Good recovery occurred after removal of the left kidney (see Figure VI.).

Chronic Pyelo-Nephritis.

My only patient with chronic bilateral pyelo-nephritis provides a striking illustration of the great value of the phthalein test in determining accurately whether or not operation on one side is possible in this condition. The patient, a man of fifty-two years, had had left renal pain for twenty years. Ureteric catheterization yielded the following results.

Urine from Kidney	Microscopy	Culture	Phthalein Test
Right	Many pus cells	Heavy growth of <i>Bacillus coli</i>	12%
Left	Many pus cells	Heavy growth of <i>Bacillus coli</i>	5%

The pain and sepsis were commencing seriously to undermine his health, so, in view of the fact that the right kidney though diseased was working well and even compensating a little, I advised removal of the left kidney. This was done. No signs of renal deficiency followed the operation nor have they since been observed. This patient has gained in weight since the operation and is still very well after three years.

Fully one half of the left kidney was a gross fibrous infarct of which the shaded area of Figure VII. indicates the extent. This area was so shrunken that it lay 1.5 centimetres below the level of the general kidney surface. Figure VIII. is a microscopical drawing of the edge of the fibrous area.

Space forbids my giving examples from the remaining groups of upper tract diseases. They may be roughly divided into three categories according to the efficiency findings.

Efficiency Always Lowered in the Affected Organ or Organs.—Hypernephroma (one case), bilateral renal calculi (one case), congenital polycystic kidneys (one case), bilateral renal tuberculosis (two cases).

Efficiency Varied According to Duration and Extent of the Disease.—Hydronephrosis (three cases), ureteric calculus (six cases), stricture of the ureter (five cases), congenital stenosis of the ureteric orifice (two cases).

Efficiency Always Found to be Normal.—Movable kidney (three cases), nephralgia due to perinephritis (four cases), oxaluria with pain and hæmaturia (four cases), adolescent albuminuria (two cases), "essential hæmaturia" (three cases), pure pyelitis (three cases).

MR. F. H. LANGLANDS said that in opening the discussion he wished to review the histories of all the patients admitted to the Melbourne Hospital affected with enlargement of the prostate during the last eight years, 1915 to 1923. The total number was 370 and of these 110 had died. The deaths included those of patients upon whom an operation had been performed and of others who did not receive operative treatment.

Two hundred and fifty-eight of the 370 had suffered complete retention of urine. Among one hundred and twenty-seven patients who were subjected to operation by a one stage procedure, there were thirty-two deaths, an operative mortality of 25%. Of sixty-three in whom operation had been carried out by a two-stage method fifteen had died, an operative mortality of 24%. In thirty-six the operative measures had been limited to suprapubic cystotomy and of these twenty-nine had died, a mortality of 80%. The number of patients for whom no operation had been performed was one hundred and forty-four and in this group thirty-four had died, a mortality of 24%.

The total operative mortality was 33.3% while that in the series of prostatectomy operations was 24.6%.

The average age of all the patients was seventy-four

years, while the average age of those subjected to operation was sixty-eight years.

The cause of death in most cases was recorded as pyelonephritis or broncho-pneumonia. Several patients had died from hæmorrhage and one from general peritonitis. In another a pulmonary abscess had been found *post mortem*. In one or two acute suppression of urine had supervened and in one patient who had died within a few hours of operation, death had been attributed to shock.

As complications he had noted stricture, dilatation and saccululation of the bladder, villous tumour (twice), vesical calculi, orchitis, epididymitis and saphenous or femoral thrombosis (two instances). Hæmorrhoids and hernia had occurred in many. Prolapse of the bowel and prostatic calculi had also been observed. In two patients stricture of the neck of the bladder had followed operation and in two fistulæ had persisted. Particular interest attached to a patient of seventy-four years of age from whom an impacted urethral calculus had been removed along with the prostate; the patient had made a good recovery.

In an examination of thirty case records in which notes of the urea content were recorded, it was found that several of the patients had died after a considerable fall had taken place in the blood urea. For example in one patient the figure for the blood urea dropped from fifty milligrammes per hundred cubic centimetres of blood to thirty-four milligrammes before the second operation; in another a fall from fifty-six milligrammes to forty-nine milligrammes took place before the second operation, but both these patients died. The reports on the whole, however, showed that when the blood urea content was low and the result of the urea concentration test satisfactory, the patients recovered. One showed a blood urea content of one hundred and four milligrammes per one hundred cubic centimetres of blood and another eighty-five milligrammes. Both died.

The diagnosis of enlargement of the prostate entailed, therefore, not only a determination of actual enlargement of the gland, but an estimation of the local and general complications as well. It was important to distinguish between the two classes of prostatic overgrowth, the glandular and the fibrous; in the former the bladder was usually dilated and retention of urine frequently occurred, but the rule in the latter was a contracted bladder and retention rarely happened.

Types of prostatic enlargement other than gross hypertrophy might cause the characteristic symptoms of frequency and difficulty of micturition, hesitation and alteration in the character of the stream. It was necessary, therefore, to determine the form and the pathology of prostatic enlargement before deciding on the appropriate remedial measures. All prostatic obstruction should be regarded as mechanical obstruction which might be physically removed by various methods and obviously the pathology would influence the mode of attack.

Special difficulty was likely to be encountered in the group in which the prostatic overgrowth was of fibrous nature, and such difficulty was due not so much to gross prostatic enlargement as to the presence of a relatively small piece of tissue at the vesical neck. Accurate cystoscopic examination might save the patient a major operation.

A small pedunculated middle lobe without general enlargement, a median bar of prostatic tissue, contraction of the vesical neck or a cyst might produce symptoms and bad effects equal to those of general enlargement of the gland. The need for methods of determining a patient's fitness and the means for improving the same were applicable to all types of prostatic obstruction. Renal function tests,

blood chemistry and clinical observation were valuable. Prostatectomy by either of the usual methods was not only unnecessary, but would probably do no good in the case of contracture of the vesical neck.

In conclusion Mr. Langlands expressed himself as convinced that the primary mortality was much more dependent upon the care exercised in the selection of patients for operation and upon the thoroughness with which pre-operative treatment was carried out, than upon the type of operation selected or the skill of the individual surgeon who performed it.

DR. BRONTE SMEATON said that the first problem the surgeon had to consider in approaching the treatment of enlargement of the prostate was the possible existence of carcinoma and the influence the decision was to have on the treatment adopted. He believed that in the Mayo clinic carcinoma was found in 15% of the operations undertaken for prostatic enlargement. It seemed possible that carcinoma arising more or less centrally in the gland might be successfully treated by removal of the prostate; in the event of recurrence the rate of growth was much slower in the bladder than elsewhere and a long period of relief might be secured. In his experience such period of relief had been as long as three years. A pathological report on every prostate removed was desirable.

Another problem was that of the efficiency of the kidneys. He had learnt to rely upon the estimation of the urea content of the blood as the most trustworthy guide and utilized the specific gravity of a twenty-four hour specimen of urine as a rough preliminary indication. He also used the urea concentration test in arriving at an estimate of the efficiency of the kidneys.

The amount of residual urine, frequency of micturition and the size of the prostate gland did not seem to correspond with any regularity with the degree of renal disease. While he realized that retention was a factor in the destruction of renal function, he did not think that it could be the only one. A high degree of dilatation of the bladder might be found in association with stricture of the urethra, but there might be no damage to the kidney. On the other hand a pelvic hydatid cyst induced fatal damage to the kidneys as a result of partial occlusion of both ureters, but there was no distension of the bladder.

In the surgical treatment of enlargement of the prostate he had found the two-stage operation of greater safety and in the presence of very great distension of the bladder he effected decompression through a Jacques catheter connected with a douche can of water. A bladder pressure that overcame a column of sixty centimetres of water declined in five days to normal and with a subsequent cystostomy the urea nitrogen came down from eighty-five milligrammes to eighteen milligrammes per one hundred cubic centimetres of blood and permitted of successful prostatectomy.

The pathology and the modification of the physiological processes of the kidney in hypertrophy of the prostate was receiving much attention. Accurate clinical observation of the polyuria that occurred after decompression, should be very interesting in this connexion; it manifested itself in several ways. After catheterization undertaken for complete retention it caused discomfiture to find that the bladder was again full in half an hour or less. The degree of polyuria was proportional to the rapidity of decompression. The sudden dehydration of the tissues of patients who poured out urine containing scarcely any solid elements, had a serious effect upon the chances of recovery.

Whatever the damage was that the kidneys sustained in these patients, they were capable of complete recovery.

DR. JULIAN SMITH complimented the two speakers from Sydney on their valuable contributions. Dr. Silverton had presented with engaging clarity the modern methods of studying renal efficiency and it was clear that these methods had now become a part of standard modern practice.

Dr. Harris had given an account of his work that won immediate attention and that in the perfection of its technique and in the brilliance of its results fell little short of the ideal. The outstanding feature seemed to be the absence of sepsis both before and after operation. He (Dr. Smith) felt bound to say, however, that a proportion of patients came before him with gross sepsis well established; in his experience many of them tolerated in-dwelling catheters badly, so that for these the two-stage technique tended to become an urgent necessity.

He understood Dr. Harris to say that if any patient failed to show satisfactory renal efficiency tests, he would be refused operation. What was offered such an one to relieve his misery? In his experience some of them "won through" if operated upon, though, of course, their chances of surviving the ordeal were not so good.

Dr. Smith then drew attention to an aspect of the subject not previously mentioned and that was the nursing. In his opinion the services of a nurse specially experienced in this class of work were of very great value and contributed in no small measure to a successful issue in the more serious cases.

With reference to technique Dr. Smith said that he preferred to keep the incision as small as possible on the principle of minimizing the area open to infection and favoured the insertion in the urethra of a No. 8 Jacques catheter through which a thread of silk was brought out of the wound. This served to draw a plug of iodoform gauze into the prostatic pouch should troublesome hæmorrhage arise. The catheter, moreover, he imagined, helped to form and determine the correct restoration of the urethra and internal meatus. He preferred to have no suction apparatus for drainage, but was quite satisfied with accurate tube drainage into a bedside bottle.

In the matter of hæmorrhage he had always been fortunate in not having been really alarmed, though occasionally it had proved disturbing. He made it a rule never to interfere actively until it was really necessary and preferred to rely on morphine and on adrenalin solution, thirty cubic centimetres of which was run through the catheter. He also administered "Hæmostatic Serum" and perhaps gave a hypodermic injection of "Pituitrin." Soon after the instillation of adrenalin a spasm of the bladder was induced and this assisted hæmostasis by expelling clot and narrowing down the prostatic pouch. The only hæmorrhage he really feared was that which came on late, accompanied by rising temperature and possibly a rigor. In a patient in whom a complication of this nature ensued, a successful issue was accomplished by the aid of transfusion of six hundred cubic centimetres of blood from his son.

Despite the tendency of the more enthusiastic to place prostatectomy among the safe operations, he felt that when patients asked him whether the operation was a serious one or not, he had still to answer that it was. For instance, during the year two apparently "good risks" had furnished absolute surprises. One patient in whom the conditions in the bladder were clean, who was in the early fifties and apparently tolerated a satisfactory and short operation after thorough preparation, died a few hours later with slight cyanosis and failing pulse despite all efforts at restoration. Another, a bright, vivacious active man with years of life in him had fallen back gasping on the seventeenth day while drinking a cup of tea and died a few hours later from pulmonary embolism.

Again, in late neglected cases (and with human nature as it was these would always occur), he had found that the already established damage to the renal cortex and cardio-vascular system tended in many to progress and that though the removal of the obstruction relieved the local misery, some patients faded away in a few months or a year or two from heart failure, mild uræmia or a mixture of both.

MR. BALCOMBE QUICK said that all surgeons realized the necessity for a decompression or two-stage operation in certain cases. He had been dissatisfied with the results of wide suprapubic cystostomy; in his experience the operative mortality was greater with the preliminary cystostomy than with the subsequent prostatectomy. Gradual decompression by urethral catheter, unless prevented by urethral stricture or prostatic deformity, was preferable, but if catheterization was not possible or the urethra was intolerant of an in-dwelling catheter suprapubic catheter drainage by small incision and purse-string suture could be carried out.

Dr. Harris' patients appeared to progress after preliminary drainage to an operable point with greater rapidity than those he had met, in whom four to seven weeks had been necessary as shown by a still rising phenol-sulphone-phthalein excretion.

The amount of residual urine was not proportional to the degree of kidney damage. Two patients with residual urine of four hundred and eighty and six hundred cubic centimetres showed a 70% and an 80% phenol-sulphone-phthalein excretion respectively and both did well.

In the presence of severe sepsis drainage by urethral catheter might not be sufficient and suprapubic cystostomy might be necessary. He regarded forced fluid intake as of great importance; a patient who restricted his fluid intake in order to avoid frequent nocturnal micturition, found that his uræmic headache was aggravated when he took a much diminished quantity of fluid. The intravenous injection of saline solution and glucose had proved of value in increasing the fluid intake.

In his experience shock and heart failure following prostatectomy occurred in direct proportion to the amount of bleeding. Local anaesthesia was preferable in the first stage operation and he employed spinal anaesthesia with perhaps local anaesthesia in addition in the more seriously ill patients.

He had met with one example of stricture at the junction of the prostatic and membranous urethra and this he regarded as being due to rough tearing across of the urethra in the delivery of a small fibrous prostate. He therefore preferred to divide the urethra deliberately with scissors after isolation by the finger. He thought post-operative bladder lavage was not sufficiently practised; it minimized the risk of secondary stone formation and the recurrence of infection in a healed suprapubic scar.

DR. L. M. McKILLOP discussed the differential diagnosis of malignant disease of the prostate gland. Many apparently simple adenomatous enlargements of the prostate contained a patch of malignant degeneration and in view of the fact that it had been noted by the Mayo clinic that 15% of surgically removed prostates were malignant microscopically, it was a pity that so many surgeons threw away the prostate without having a microscopical examination made. Several points were of importance in the diagnosis of malignant disease.

In the first place there might be little or no actual enlargement. In rare cases there might even be shrinkage, but there was almost always an early absence of the median furrow so constant in ordinary adenomatous enlargement.

The second point was that there was early fixation of the gland if an attempt was made to move the capsule laterally. If it could be determined that the lateral pelvic lymphatics were implicated and that the disease had thus overstepped the limit of the fascial capsule, the patient was beyond the assistance of the surgeon.

The third point concerned the question of pain in the penis at the end of micturition. This was almost unknown in tuberculosis and in simple adenoma and was due to early involvement of the prostatic urethra by the malignant process. The prostate gland had a very poor blood supply and this probably explained the slowness of growth when the cancer commenced in the depths of the gland. When, however, the growth began in the middle lobe, it progressed more rapidly owing to the richer blood supply from the prostatic plexus.

The fourth point concerned the feel of the prostate to the examining finger. The gland except in advanced cases was not uniformly hard, but presented densely hard nodules alternating with patches of comparative softness. If the nodular hardness were definitely felt just below the seminal vesicle, the diagnosis of cancer could be made with safety. There were two other conditions in which nodules were felt in the prostate, tuberculosis and calculus. In tuberculosis there was usually implication of the vas, epididymis or seminal vesicles (which latter in health were not palpable), before the disease attacked the prostate and there might be coincident signs in other parts such as the lungs. Moreover, a patch of fluctuation might be made out; there might be rise of temperature and there was no fixation of the gland capsule. In prostatic calculi there was no enlargement of the gland and by firm pressure the calculi might be made to slip against one another. Lastly, in some cases a sound might grate upon the point of a calculus which had ulcerated into the prostatic urethra.

With reference to the technique of the operation of prostatectomy Dr. McKillop said that he always employed a large incision into the bladder, so that he could see as well as feel what he was doing. He left a catheter in the urethra after operation and fastened a plug of gauze soaked in "Hæmostatic Serum" to it, if hæmorrhage became troublesome. It was easier to take the catheter out than to put one in after operation. It was necessary to exercise great care not to decompress the kidneys suddenly before operation, as this might set up bleeding and do damage from which it might take weeks to recover. Another very essential point was to keep the urine acid throughout the whole course of treatment. From the time the urine became alkaline, complications were likely to ensue.

Dr. H. B. DEVINE said that everybody was agreed that no prostatectomy should be done without the most careful preliminary treatment. Years ago he had learned that a preliminary cystotomy was not satisfactory. Operation through the cystotomy wound was difficult; there was always a mild degree of sepsis and apparently the release of pressure was too sudden, because in one case pure blood was noticed.

He found a very real difficulty in the preliminary treatment with regard to catheterization in the public hospital, where resident officers were not careful in their technique and also because they were not expert in the use of the catheter. In private work he had very little trouble in the preliminary treatment, because he did it himself and he found that it was necessary to exercise the greatest care in the preliminary catheterization. At first he found it very difficult and the urethra very intolerant.

With regard to the operation Dr. Devine stated that it was necessary to reckon with a mild degree of sepsis.

The retained catheter always produced a mild infection and several times after he had removed the prostate, he had cut it across and had been able to squeeze a little pus out after persistent catheter treatment. This mild sepsis with the blood cloth which was present after the operation and the warmth and darkness of the bladder, gave every facility for a germ to grow. For this reason he was not anxious for the cystotomy wound to close sooner than three weeks. He thought that the prostatectomy cavity healed quicker with the cystotomy wound open. When he allowed the cystotomy wound to close very quickly it was necessary to wash the patient's bladder out for some time.

He referred to a system of continuous suction drainage which he had used for the six or seven years. A tube surrounded by wire gauze was introduced to the bottom of the bladder and fixed by set screws. This was attached to a pump which kept the bladder perfectly dry. By pinching the suction tube and introducing a little "Eusol" periodically it was possible to keep the bladder thoroughly antiseptic without washing it out. When the tube was taken out after six or seven days, it was possible to elevate the suction apparatus to the orifice of the bladder, so that the bladder was dry from the operation till the time the wound was completely closed. He had had the very greatest value from this apparatus. The wounds were always perfectly clean. There was not the usual unpleasant smell. It had entirely altered the mortality rate.

He wished to ask if others had had any trouble with hæmorrhage from ten days to a fortnight after the operation. It had occurred occasionally in his practice. He had had very little trouble with bleeding at the time of the operation. He took out the prostate very carefully and paid special attention to the bleeding points after the operation.

Another class of case which he had seen, was that in which there was incomplete function of the bladder.

surgeon might be satisfied with the function, but very often the patient was not. In these patients the trouble was ascribed atony of the bladder, but he had found that it was often due to mild degrees of obstruction; when this had been removed, there had been perfect function. These results should not be put down against prostatectomy. They were really due to the fact that the operation had not been very faithfully carried out.

Dr. S. HARRY HARRIS in reply said with reference to hæmorrhage that he rarely found it necessary to pack the prostatic cavity. Reopening of the wound, irrigation with hot water and replacing the tube for two or three days usually met all requirements. The small hard prostate glands were usually fibrous rather than adenomatous and the obstruction was at the bladder neck. They should be dealt with either by removing a portion with a punch *per urethram* or by suprapubic cystotomy and cutting out a wedge-shaped piece.

He did not favour the prolonged drainage advocated by other speakers; the more quickly the suprapubic wound healed, the better the patients progressed and the longer they were drained, the more likely were they to become infected.

With reference to Mr. Langlands's statistics and particularly the very high percentage admitted to hospital with retention Dr. Harris said that it was essential that practitioners should refer these patients for treatment long before the stage of retention was reached.

Much could be accomplished in the matter of intolerance to an in-dwelling catheter by gaining the patient's confidence and using a small catheter. He preferred a No. 6 or No. 7 Coudé to a rubber Jacques catheter, as being

easier to introduce and to maintain in the correct position just within the neck of the bladder.

It was difficult to carry out suprapubic drainage under local anaesthesia, because it was necessary to place the tube as high as possible in the bladder. The high situation of the bladder when distended and the necessity for stripping back the peritoneum made suprapubic cystotomy unsatisfactory under local anaesthesia.

He agreed as to the utility of lavage in certain cases. When the urine had not become clear by the sixteenth or eighteenth day, he washed the bladder clear with water and left in one hundred and twenty cubic centimetres of a 0.03% solution of silver nitrate for a few days and this usually sufficed.

In conclusion Dr. Harris expressed doubt that malignant disease ever commenced in the centre of an adenomatous prostate.

The President, DR. R. GORDON CRAIG said that the lines of future progress lay not so much in the technique of the operation as in the recognition of hypertrophy of the prostate in its earliest stages, the careful selection of patients for operation and the detailed attention to pre-operative and post-operative treatment.

DIAGNOSTIC METHODS IN HYDATID DISEASE.

By HAROLD R. DEW, F.R.C.S. (England),
and

MISS F. WILLIAMS,

*From the Walter and Eliza Hall Institute for Research in
Pathology and Medicine.*

DURING the past three years various workers at the Institute have been investigating the immunity reactions in hydatid disease. This work was commenced by Dr. N. H. Fairley who laid down a high technical standard which has been gradually further developed. It is now recognized that these reactions are the most valuable diagnostic aids that we have at our disposal. The tests performed are three in number: (i.) the complement fixation test, (ii.) the precipitin test, (iii.) the intradermal test of Casoni.

Complement Fixation Test.

The first and most important is the complement fixation test. This depends on the presence in the body fluids of a person suffering from hydatid disease of a specific antibody induced by the absorption of specific hydatid protein which acts as antigen.

This antibody in the presence of specific antigen combines with normal complement and the latter cannot then be demonstrated by means of a sensitized system consisting of red blood cells and specific hæmolysin.

The reaction is performed in the same way as the Wassermann test. The presence of hæmolysis indicates that complement has not been fixed and shows that antibody is not present.

Technique.

Dr. N. Fairley performed many interesting experiments to ascertain the most useful and reliable antigen to use and came to the conclusion that clear, uncontaminated hydatid fluid from the cysts of the sheep was the best for routine purposes. This fluid is difficult to preserve and it has a variable antigenic content which causes variations in the quantitative readings.

These facts have led to further experiments to discover a more stable, constant and reliable antigen. We have after many trials achieved this and undoubtedly the use of this new antigen will lead to considerable improvement in the results.

The tests as performed at the Institute are quantitative, both the Harrison and the ice box method being used. In most of the tests recorded in this preliminary communication fresh hydatid fluid was used as antigen.

The results are recorded as follows:

P + = fixation of two minimum hæmolytic doses by the Harrison method and three minimum hæmolytic doses by the ice box method.

P + + = fixation of three minimum hæmolytic doses by the Harrison method and four and a half minimum hæmolytic doses by the ice box method.

P + + + = fixation of four minimum hæmolytic doses by the Harrison method and six minimum hæmolytic doses by the ice box method.

Specificity of the Test.

During the routine performance of complement fixation tests for syphilis, hydatid disease, gonococcal infections and tuberculosis some five thousand sera have been examined. In no instances have any proved pseudo-positive reactions been observed, although there have been a few unconfirmed cases. The test appears to be absolutely specific and a reaction invariably means either previous or existing hydatid disease. Eight cases of infestation with other helminths were investigated with uniformly negative results.

Sera derived from patients suffering from almost every disease met with in hospital practice were examined and negative results obtained.

In a number of cases of intra-abdominal tumours, including ovarian, omental and pseudo-pancreatic cysts, in which the clinical diagnosis of hydatid disease had been made, the validity of the failure to react to the fixation test was upheld at operation.

Factors on Which the Reaction Depends.

The factors on which the reaction depends, are three in number: (i.) The production of a specific antigen by the parasite, (ii.) the absorption by the body of this antigen in sufficient quantities and over a sufficiently long period to stimulate the production of the specific antibody, (iii.) a reaction on the part of the tissues of the host.

There appear to be some cysts, especially those which are barren, in that they have not produced scolices, in which the antigenic properties are low or absent. Dead cysts which have undergone fibrosis or calcification or those which have degenerated or have been the site of chronic suppuration, produce little or no antigen and in all probability will not give rise to a diagnostic reaction.

In these cases, no doubt, this result is more likely to occur if sufficient time has elapsed since the death of the cyst to permit of the disappearance of the antibody from the blood.

In order that absorption of antigen should take place, it is essential that it should make its way through the thick laminated membrane and then through the occasionally very dense adventitious layer elaborated by the host.

The laminated membrane appears to be laid down by the parasite as a protective covering and is probably endowed with peculiar properties as regards permeability to this end. This membrane, if intact, would probably resist the passage of the specific protein more efficiently than the more or less vascular adventitia which subserves the nutrition of the cyst.

It is the lack of absorption of the toxin which leads to the greater number of "negative" results.

Operative interference in the form of incision and drainage or exploratory puncture leads to increased absorption of hydatid antigen and a subsequent rise of the antibody content of the blood. This is shown by the fixation of as many as eighteen minimum hæmolytic doses of complement in some cases after operation.

Partial or complete rupture of a cyst into the body cavities or into a bronchus usually has the same effect.

Recent suppuration which is a common complication, almost invariably causes a rapid increase of the circulating antibody and a corresponding increase in the amount of complement fixed. The following table emphasizes this.

TABLE I.

Condition of Cyst	Number Examined	REACTIONS	
		Number	Proportion
Uncomplicated	60	28	76%
Recent rupture	12	11	91.7%
Recent suppuration	21	21	100%

Failure of the immunizing mechanism may also be a factor and is the probable explanation of the failure of some cases to give a positive fixation. This is especially the case where the resistance of the patient has been overwhelmed by chronic disease or by severe or long continued suppuration.

Application of the Tests to Clinical Medicine.

Patients with hydatid disease as regards their immunity responses fall into two main groups: (i.) those on whom no previous operation has been performed and of whom there has been no history suggestive of hydatid disease, (ii.) those of whom there is a history of previous hydatid disease.

In the first group there were one hundred and sixty-nine patients. Of these one hundred and thirty gave positive results which were confirmed at operation or clinically, that is 81%. In thirty patients or 19% the test did not lead to fixation of complement. An analysis of the latter class is of great interest and reveals the following types:

(1) Degenerating, fibrotic, calcareous cysts or those in which long continued suppuration has occurred; this occurred in ten.

In this type of case no antigen is being produced and any antibody that may have been present in the blood, has disappeared. No complement fixation can be expected to occur in such cases.

(2) Hydatid disease occurring in children. There were six. A failure to react is common in uncomplicated dis-

ease in children and is certainly due to lack of absorption of the specific protein, as the fluid invariably shows considerable antigenic properties and in all the patients the power to fix complement appeared after operation.

The typical hydatid cyst in children usually has a thin adventitious capsule and rarely shows any daughter cysts. Complications as have been noted above are a very important factor in the absorption of antigen and no doubt the younger the patient, the less likely these are to occur.

In hydatid disease in children in whom daughter cysts are present or in whom complications have occurred, it is usual to find a positive fixation reaction. These facts appear to give confirmation to the view we have held for some time that the formation of daughter cysts in echinococcal disease in human beings is related to the age of the cyst and the possibility of trauma.

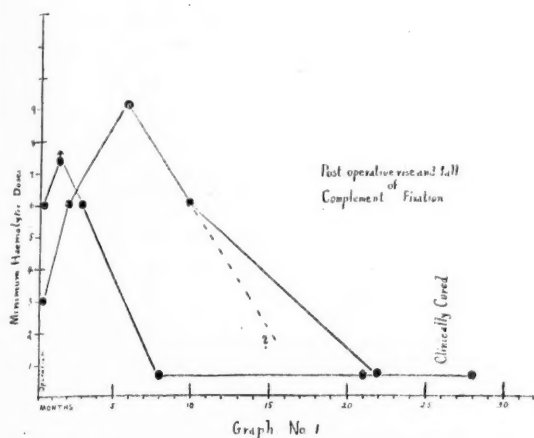
(3) Simple hydatid cysts of the lung; this was encountered six times. In these cases failure of absorption of the antigen is undoubtedly the factor, as post-operative fixation reactions developed in all. It is of interest to note that in primary lung hydatid cysts daughter cyst formation is often absent and the adventitia is often thin. Possibly, they give rise to symptoms earlier than cysts in other situations and are diagnosed and operated upon before complications occur. When rupture into the pleura or bronchus occurs, as a rule a reaction is obtained.

(4) Various types of cysts; these occurred in three. They comprised cysts in muscle, liver, pelvis bones *et cetera*. In some of the patients post-operative positive fixation developed but in some of them, owing to insufficient evidence, no explanation of the failure to react can be offered.

Various antigens have been tried in order to reduce, if possible, the number of these negative findings. At present the respective merits of two are being investigated. The first is an alcoholic extract of scolices obtained from the hydatid cysts of the sheep; the second is a saline solution extract of scolices which have been digested with trypsin. These are proving very satisfactory and it is certain that the improved sensitiveness of these antigens will enable us to recognize much smaller quantities of antibody in the serum and correspondingly improve the percentage of positive results. Another important advantage will be that the antigen prepared in this way will be stable and constant, so that reliable and comparable figures will be possible over a long period.

In the patients of the second group the reactions are extremely interesting. All probably had absorbed some of the hydatid antigen and no doubt all, at some time, would have given a positive complement fixation.

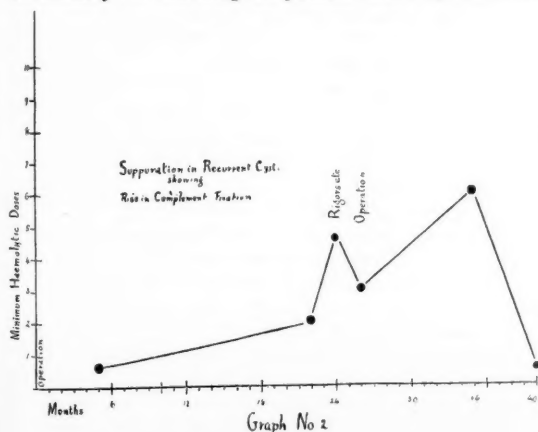
After operation or rupture the amount of complement fixed usually rises except in the rare cases in which it is possible to remove the whole cyst at operation. This post-operative rise may be preceded by a short "negative" phase during which time the tissues of the host appear to elaborate antibody. After the post-operative rise the amount of complement fixed falls and in cured patients no reaction is obtained. Graph I. shows the records of two cases of this nature.



The disappearance of circulating antibody does not take place so rapidly as would be expected and it is at least twelve months before any definite prognostic value can be placed on this test. It has to be remembered that hydatid infestation is much more frequently multiple than is generally recognized and that any persistence of the reaction should at once arouse suspicions of the presence of another cyst. Certainly the persistence of a "P + +" or a "P + + +" reaction after twelve months is almost positive proof of another cyst and should be sufficient evidence for advising exploration.

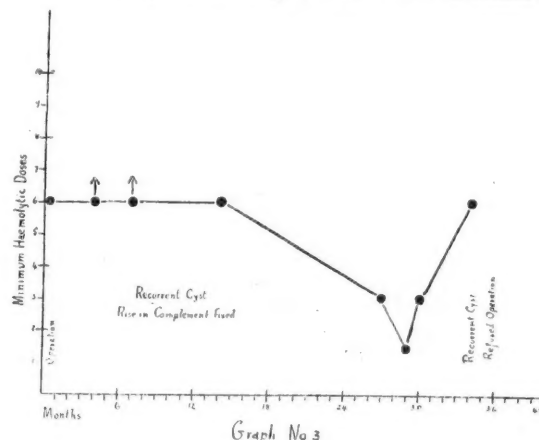
The exact time relations of these post-operative changes in circulating antibody is not yet certain, although we are collecting a great number of observations. It will be some time before a full understanding of the phenomena will be possible.

Another problem is concerned with the recurrence of the disease from the growth of a small daughter cyst shed at the first operation. These take some time to grow and produce enough antibody to be recognized, so that the fixation curve may show a drop almost to normal with a secondary gradual rise as the new cyst develops. The onset of complications in the second cyst may also be shown by a rise in the deviation curve. These facts emphasize the necessity of following all patients after operation for



a long period. Graph II. and III. illustrate the value of the fixation test from this point of view.

In Graph II. the patient had had a cyst of the liver drained. Two years after operation she had an attack of



pain, rigors *et cetera* and the old scar showed some bulging. The complement deviation curve showed a rise and the patient on operation had a suppurating cyst in the region of the old scar. In Graph III. thirty months after operation the complement fixation had almost dropped to normal, but a definite rise then occurred and the clinician reported the presence of another cyst, although the patient refused operation.

The value of the fixation test in these post-operative cases is strikingly shown by the following table of the results of the test in one hundred and twenty cases of this kind.

TABLE II.

Number Examined	No Fixation	No Fixation but Proved Hydatid	Fixation	Fixation and Proved Hydatid
120	57	3	63	54

Thus in sixty-three patients whose serum reacted in the test, it was possible to prove at operation that there was either a recurrence or persistence of the disease. In the remaining patients reacting there was sufficient clinical evidence to arouse suspicion that other cysts were present.

Enough has been said to indicate that in this test we have a diagnostic method of great and proved value. It is essentially a quantitative test and with improved technique and with continued experience we shall be able to rely on it to a much greater extent. There are still many problems of interest and importance both to the clinician and to the immunologist and some of these are at present engaging our attention.

The Precipitin Test.

The second reaction which we have reinvestigated at the Institute is the precipitin reaction. This is one of the first reactions investigated by scientific workers in hydatid disease and much work was done in Australia, especially by Welsh, Chapman and Storey.

This reaction depends on the production by the cells of the tissues of the host of a specific precipitin in response to the absorption of the hydatid protein. The serum containing this substance has the power of causing a precipitate when added to a solution of the specific protein.

Technique.

This in its present form is simple and is carried out as follows. The antigen which has been found to be most satisfactory, is fresh hydatid fluid obtained with sterile precautions from the cysts of the sheep. The addition of carbolic acid to make up to a strength of 0.5% as shown by Dr. K. Fairley, enables it to be kept. This antigen remains remarkably stable over a period of several months without deterioration.

About 0.4 cubic centimetre of fresh, unheated serum from the patient is added to an equal quantity of the antigen in small bore agglutination tubes and allowed to stand for thirty-six hours at room temperature.

Control tubes containing known reacting and non-reacting sera and both antigenic and serum controls are also put up.

In a serum with high precipitin content a precipitate forms in two or three hours. The final reading is taken in about thirty-six hours. An attempt was made to make the readings quantitative, but this is difficult with the test in its present form. Thus the formation of a thick flocculent precipitate in the bottom of the tube was taken as a "P + + + " reaction. A fine precipitate at the bottom and fine granules scattered throughout the fluid was taken as a "P + +" and a fine granularity only visible through a lens as a "P +" reaction.

Our subsequent experience has led to the conclusion that the "P +" reading is much too indefinite for general use and in some cases its interpretation as positive has led to error.

Value of the Test.

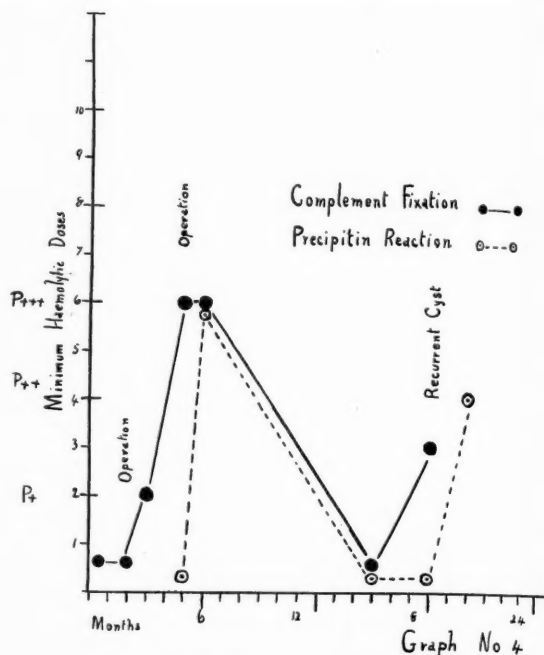
As would be expected the precipitin and the complement fixation tests run parallel with each other. Both are specific and both depend upon and are modified by the same factors.

The precipitin test, however, in its present form is not so delicate nor is it quantitative in the same way as the complement fixation reaction.

It is a simple test and, if gross readings (corresponding to the "P + + + " or the "P + +" reaction) be alone relied upon, it can be performed and interpreted without any special laboratory training. Used with this reservation the test is within the reach of all practitioners. It is now performed as a routine test at the Institute along with the complement fixation test.

In the pre-operative series twenty-six patients were examined and a positive reaction obtained in eighteen or 70%.

In post-operative cases it followed very closely the complement deviation test, but whereas the "P + +" complement fixation (the fixation of two minimum hæmolytic doses) is a very definite reaction, the small amount of precipitating antibody in the corresponding cases could rarely be demonstrated. The following graph shows the correlation of the two tests in a post-operative case.



The Intradermal Test of Casoni.

The test consists in the intradermal injection of 0.4 cubic centimetre of hydatid fluid. The fluid is obtained with sterile precautions from the hydatid cysts of the sheep and is filtered through a Berkefeld filter before use. An intradermal injection of normal saline solution forms a necessary control.

The interpretation of the reaction needs some experience and it appears to be of a triphasic nature. In a typical positive case a wheal appears at the site of injection about the size of a shilling to that of a half crown. This appears as a rule within twenty minutes. An area of erythema and swelling then appears around this and extends until a very large area of the arm is involved. There is no pain, the area is usually itchy and on palpation an area of deep induration may be felt. As this erythema appears, the urticarial wheal disappears. The erythema is evident after twelve hours and may persist for forty-eight. There is no general reaction.

Another type of reaction is as follows. A wheal appears and persists for some hours and then disappears. After twelve to twenty-four hours a large area of erythema and swelling appears around the site and persists for forty-eight hours.

Another type of reaction is the appearance of a wheal with perhaps a small area of erythema which persists for a few hours and then disappears completely. It is essential that the patient should be under observation for at least twenty-four hours. The exact meaning of these varied reactions is not quite certain.

The reaction is probably due to the sensitization of the tissues of the host to the specific hydatid protein and there appears to be an anaphylactic as well as a toxic element in the reaction. The urticarial wheal represents the

anaphylactic element and the erythema the toxic. The true nature of the reaction is at present being investigated.

Value of the Test.

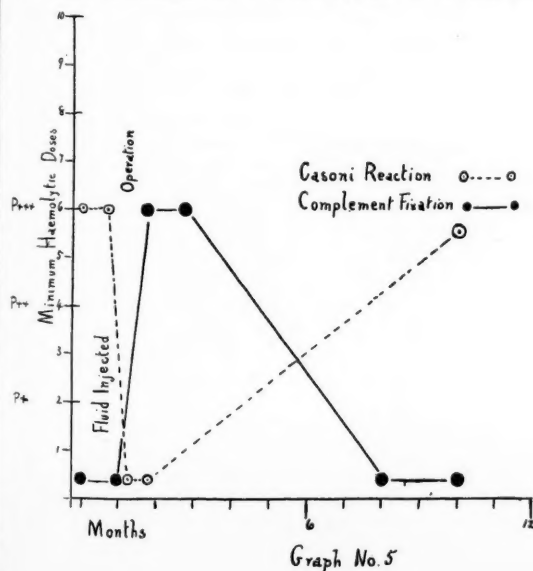
The test is absolutely specific, but care has to be taken in its interpretation and adequate controls are necessary.

In pre-operative cases is it alone of value. A response does not follow the fixation or the precipitin reactions. It is usually absent when they are strongly developed and present when they are absent. In some of the post-operative cases variations to this rule occur, however, and occasionally all three tests may yield reactions. In Graph VI. a typical finding is depicted and it can be understood from the graph that over a certain period during which the "crossing" is taking place, indefinite readings may be obtained.

If the Casoni test, however, induces a reaction in a patient with no previous history of hydatid infestation, even if the other tests fail to yield evidence of hydatid disease, it means that the patient is suffering from hydatid infestation. The test is not quantitative, but if used in conjunction with the other tests it is of great value and will undoubtedly be very useful in picking up cases of uncomplicated cysts in which there has been absorption of hydatid fluid insufficient to give rise to the production of enough antibody to be detected by the relatively coarse methods of complement fixation.

After operation or the onset of complications to the cyst there is an increase in the amount of circulating antibody as indicated by the development of a strong fixation reaction. This may be accompanied by a disappearance of the Casoni reaction. In all post-operative cases the response to the Casoni test is variable and a positive reaction simply means that the patient has had hydatid disease. It may be that the increase in circulating antibody is in itself the cause of the disappearance of the Casoni reaction, the sensitive body cells being protected by it from the locally injected antigen.

In some circumstances it would appear as if this pro-

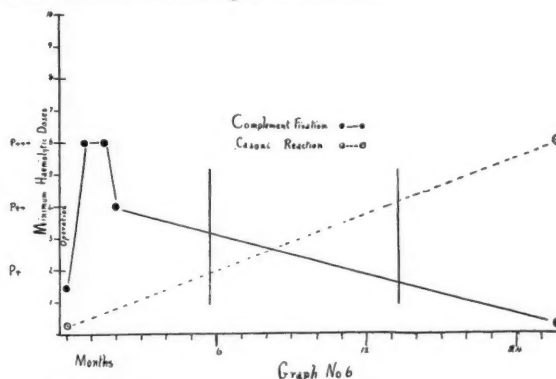


TECTIVE effect remains for some time, but there are indications that with the disappearance of the antibodies from the blood the patient again becomes sensitive, so that the Casoni reaction may be elicited many years after operation, even in a cured patient (see Graph VI.).

The exact correlation between all the tests is rather difficult, but it is hoped that the work at present being undertaken at the Institute will throw new light on this problem.

Graph V. illustrates the effect on the result of the Casoni test of the purposeful injection of hydatid fluid into a patient suffering from a recurrent cyst in whom the complement fixation test was negative.

Graph VI. illustrates a very common observation; some two years after operation the Casoni test yielded a reaction; there was no complement fixation and the patient manifested no clinical signs of infestation.



The following is a summary of the value of the three tests.

(1) The complement fixation test is still the most reliable test at our disposal and gives positive findings in over 80% of all patients with hydatid disease. It is almost certain that the use of more sensitive antigens will improve these figures.

(2) The precipitin test follows very closely the above test, but it is not so delicate nor in its present form quantitative. It has the merit of being easy to perform and is an important addition to our methods.

(3) The Casoni test is a very sensitive one and is of the greatest use in the detection of uncomplicated cysts before operation.

(4) A combination of all these tests is the ideal and by the use of the Casoni and the complement fixation tests at least 90% of cases of hydatid disease should be diagnosed.

In conclusion I would like to appeal to all practitioners to cooperate with the workers at the Institute and help in the solution of the interesting and important problems associated with these reactions.

They can do this by sending progress notes, confirmation at operation and specimens of blood for examination at frequent intervals.

There are many immunological phenomena of great interest in this disease and the explanation of them will throw light on those occurring in other diseases. If the clinicians will realize this and help on the work it will be carried out and completed in a scientific manner.

THE USE AND ABUSE OF THE DRAINAGE TUBE
IN OPERATIONS ON HYDATID CYSTS.

By W. J. STEWART MCKAY, M.B., M.CH., B.SC.,
Senior Surgeon, Lewisham Hospital, Sydney.

THE chief object of this paper is to show that the drainage tube should not be used in treating hydatid cysts of the liver, except when suppuration is present.

In abdominal cysts found among the intestines the drainage tube is not required. The ectocyst is opened; the endocyst is removed and the ectocyst is dropped back. This is Bond's operation. I operated on a large hydatid cyst of the spleen recently and after removing the endocyst I fastened the ectocyst to the abdominal wall and closed the incision.

The battlefield to-day is the liver. Lindemann was the first to make a deliberate incision into a hydatid cyst of the liver. He fixed the ectocyst to the incision in the abdominal wall and inserted a drainage tube. Lawson Tait some years later did the same operation and this established the mode of operation in hydatid cysts that has been almost universally adopted. It is against this method that I wish to wage war.

In 1883 Knowsley Thornton having encountered a hydatid cyst of the liver, operated, removed the endocyst, fastened the ectocyst to the abdominal wall and closed the incision. He did not insert a drainage tube. This is the type of operation that I have followed for the last twelve years and it is the operation that should be performed unless the cyst contents are septic. Then a tube may be employed to drain.

Mr. Hamilton Russell in 1895 opened hydatid cysts of the liver, removed the endocyst and returned the ectocyst, but did not suture the opening nor fix it to the abdominal incision. Mr. Russell has now given up this operation. At a later date some of the Melbourne surgeons after removing the endocyst, filled the ectocyst with "Formalin" solution and closed the opening in the ectocyst and returned the whole into the abdominal cavity. Mr. Kilvington is the chief advocate of this plan with which I do not agree. The cyst has to be opened in some cases a second time and in others the "Formalin" solution has apparently been the cause of the death of the patient. The operation that I have performed during the last twelve years is as follows.

The skin is prepared with great care; the incision is made and at once gauze is fixed to the skin edge. The ectocyst is transfixed with a needle carrying No. 3 catgut. The ectocyst is then opened and the endocyst removed. If daughter cysts are present, a rubber tube is attached to a bottle that is connected with an electric exhaustor. When the tube is inserted into the cyst cavity, the fluid and the daughter cysts are at once sucked into the bottle and the inside of the cyst is cleaned most perfectly. The ectocyst is fixed to the abdominal incision and the skin is closed over the opening in the ectocyst.

If I am dealing with a clean case, I maintain that having fixed the adventitial sac to the abdominal incision, a drainage tube shall not be inserted. I used a drainage tube years ago when I encountered daughter cysts, as I

found that it was often impossible to remove all the daughter cysts, but since I have used the electric suction apparatus, everything in the cyst cavity can be removed most perfectly. Once a complication occurred with this method, which is instructive. I emptied a cyst of the liver and fixed the ectocyst to the abdominal wall and closed the incision. The patient returned home and after a month the husband wrote to say that the wound had opened and hundreds of daughter cysts were pouring out. What had happened was this; there had been a second cyst and it had burst into the ectocyst cavity that I had emptied and the daughter cysts had burst through the abdominal parietes.

If a bile duct opens into the emptied ectocyst cavity, bile will be poured out and it will find its way out of the wound sooner or later. A drainage tube may then have to be inserted.

Now before I leave the liver I wish to say that if you want the operation that I am advocating to be a success, I strongly advise that as soon as the skin incision is made, gauze be attached to the skin edges. Whether it be a bone or a knee joint, a brain or a liver that we are operating on, one of the chief dangers is infection from sweeping the germs on the skin into the wound. Lane and others have maintained that the great danger in bone surgery comes from introducing the fingers into the wound. That may be true, but if you cover the fingers with a glove and you hide the skin from view, you can introduce your fingers as much as you like. I show you here a good example to illustrate what I mean—a chronic alcoholic with a humerus broken in five places; the operation lasting one hour and a half; the fingers in the wound all the time and yet the wound healed without a drop of serum; and why? Because gauze was sown to the edge of the wound the moment the skin was cut through and so it is with hydatid cases; if you want to get good results, you must sew gauze to the edges of your wound the moment you cut through the skin.

Now, let us consider hydatid cysts of the lung in regard to drainage. Whilst writing this paper a woman presented herself on whom I had already operated sixteen times for hydatids in various parts of the body. For ten months she had coughed day and night and used to expectorate pieces of membrane which were regarded by her medical attendant as pieces of daughter cysts. I had a skiagram taken of her chest by Dr. Harrison at the Lewisham Hospital and as you can see, the hydatid is shown very plainly. I cut away part of one of her left lower ribs, the rib below I had previously removed in operating on a hydatid cyst with daughter cysts. When I opened the pleural cavity and looked in, I could see the lung like a solid body and each time the heart beat, it threw the lung up with a tremendous jerk. At first I could not see the hydatid, but in trying to steady the lung with a depressor, I turned up its base and immediately saw a surface the size of a penny whose white colour indicated the hydatid cyst. I passed a curved needle into the ectocyst which was quite thick, and seizing either end with catch forceps, brought the base of the lung to the incision, where I fixed it with catgut. I opened it, found the cavity ten centimetres (four inches) deep and removed the broken endocyst and several ounces of turbid fluid.

There were no daughter cysts. I wiped the walls dry and then came the time when I had to decide whether I would insert a drainage tube or not. I had the day before operating taken the opportunity of reading through Dr. Lendon's monograph on "Hydatid Disease of the Lung" and had noticed that he said that if a drainage tube was not used, there was the danger of emphysema. Nevertheless, I thought that I would risk it, so I closed the wound. The patient coughed a good deal during the night and brought up some blood-stained fluid; when I saw her next morning, I could hardly recognize her because her face was so horribly changed, for as the cyst walls contracted, some blood vessels had ruptured and a little blood had been poured out into the cavity of the ectocyst and this the patient had tried to expectorate. Her coughing efforts had forced the air to the site of the incision and the air not being able to get out, had travelled up by way of the subcutaneous tissues over the chest to the neck and face and had closed the eyes, so great was the emphysema. I at once took out a skin suture and the air came whistling through with some blood-stained fluid, whenever the patient coughed. I inserted a drainage tube which I left in for a few days, and then removed it. All this caused the patient little pain and was done in her bed. The emphysema which made her feel as if a band were round her chest, lasted three or four days, but everything then became normal in appearance. A blood-stained fluid came in small quantities for two weeks from the small opening in the incision, so I determined to strap up the opening and see what would happen. To my great joy the opening closed at once and the patient had no more cough and went home well.

In another lung patient on whom I operated, I did not use a drainage tube, but closed up the incision. There was no apparent communication in this case between the cyst and the bronchial tubes. After about eight days some blood-stained fluid began to come through the skin incision and I removed a stitch and one hundred and twenty to one hundred and forty cubic centimetres (three or four ounces) of this blood-stained fluid came away, but the wound healed almost at once.

From these cases and others that I have done, it appears that it is advisable to use a drainage tube in hydatid cysts of the lung, whether they communicate with a bronchial tube or not, because there is sure to be some blood-stained fluid that should be allowed to escape. The tube need only be used for a few days.

Let me in ending say again that the operation originally performed by Knowsley Thornton on a hydatid cyst of the liver is the type of operation that should be adopted. It is to be preferred to the Lindermann-Lawson Tait operation because the drainage tube means infection sooner or later and that means weeks and months in bed for the patient. The Thornton operation is to be preferred to either the operation advocated by Hamilton Russell or Kilvington, because these surgeons do not attach the ectocyst to the abdominal incision, but abandon it and in doing that they subject the patient, in liver hydatids, to an unnecessary risk that can be avoided by the Thornton method which I have followed now for the last twelve years and have not had a single death.

FACTORS IN THE SURGICAL TREATMENT OF HYDATID DISEASE.

By B. T. ZWAR, M.D., M.S.,

Honorary Surgeon to In-Patients, Melbourne Hospital.

THERE are certain milestones in the evolution of the surgical treatment of hydatid disease in Australia.

The treatment of hydatid disease is a subject of special interest to Australian surgeons, not only because Australia has long enjoyed an unenviable reputation for the prevalence of this disease, but also because members of the profession in Australia have made important contributions towards the methods of effectively dealing with it.

Previous Medical Congresses in Australia stand out as landmarks in the evolution of the treatment of hydatid disease. Some of you may remember the Intercolonial Medical Congress of Australasia held in this city in July of 1889. At that Congress Dr. J. Davies Thomas and Dr. William Gardner of Adelaide expounded the treatment of hydatid disease by incision then generally adopted by what was known as the Adelaide School. The vastly better results obtained by the more radical methods of operating carried out by its followers rang the death knell of other methods now long obsolete which were then employed.

Since then the operation described by Mr. C. J. Bond, F.R.C.S., of Leicester (1) has been the basis for important advance in the treatment of cases of non-infected hydatid disease.

Later still Mr. Hamilton Russell (2) reported the recovery of a patient with a large infected hydatid cyst of the liver operated and closed without drainage. In this patient the foul smelling, bile-stained contents, fluid and daughter cysts, had been cleaned out, the adventitial sac filled with salt solution, accurately sutured with silver wire returned into the abdomen and the abdominal wound closed; the patient was able to leave the hospital quite well twenty-four days from the date of the operation. Mr. Russell contrasted this with a similar case in which he had employed drainage, and which had terminated fatally from hæmorrhage sixteen days after the operation.

The problem involved in the treatment of hydatid disease is not only how to secure for the sufferer the safest and quickest recovery, but also how to achieve permanency of cure and avoidance of reinfection from the source treated.

In the case of large hydatid cysts and especially in large loculated ones the difficulty or impossibility of cleaning out of the adventitial sac all the daughter cysts and hydatid elements is well known. It is equally well known that the adventitial sac of a hydatid if not infected at the time of operation soon becomes infected after operation if drainage is employed. When death occurs after operation with drainage, it is due generally to some septic complication.

(1) C. J. Bond, "On the Treatment of Hydatid Disease by Incision and Evacuation of the Cyst without Drainage," "The British Medical Journal," April 11, 1891, page 795.

(2) Hamilton Russell, "The Treatment of Large Infected Liver Hydatids," "The Intercolonial Medical Journal of Australasia," October 20, 1907, page 534.

The question whether recurrences due to implantation result from daughter cysts or some of the hydatid elements is still a matter for debate. The modern view based on biological grounds favours the opinion that they result from the implantation of daughter cysts. It is known, however, that daughter cysts may prove extremely resistant.

These views have led to the certain innovations in the treatment of hydatid disease. The treatment should aim at the most rapid recovery with due regard to safety and the elimination of the risk of re-infection and sepsis. The problem of how best to render harmless daughter cysts and other hydatid elements is one towards the solution of which French workers have contributed much thought and investigation. As long ago as 1901, Dévé, as a result of his investigations advised the injection of "Formalin" into the hydatid cyst before it evacuation and claimed that this precaution obviated or lessened the risk of recurrences.

With experience the strength of the "Formalin" dilution has been increased and Mr. Kilvington who is a strong

hesitated to leave it in the adventitia when the same is closed.

The method which I have practised, is to expose the hydatid cyst by an incision over the most prominent part of the swelling. After its exposure the edges of the wound and the surrounding viscera are carefully packed off. With a large syringe a quantity of the contents of the cyst is then drawn off, the barrel of the syringe is disconnected, emptied and a 10% dilution of "Formalin" about equal to the quantity of the fluid withdrawn is injected into the cyst. After an interval the cyst is incised, the adventitial sac is emptied, swabbed out with gauze moist with a 10% dilution of "Formalin"; it is then packed with gauze moist with this fluid and this is allowed to remain in it for some minutes. The gauze having been removed, the sac wall and the surroundings of the opening are cleansed with gauze moist with normal saline solution; the sac is then filled with normal saline solution and is carefully sutured by a double line of sutures, the suture line being reinforced by omental or other grafts if such is

TABLE I.

Cases of Hydatid Disease Surgically Treated at Melbourne Hospital during 1917 to 1922.

Position of Parasite	SEX OF PATIENTS			Erroneous Provisional Diagnosis	OPENED AND DRAINED				OPENED AND NOT DRAINED			
	Both	Male	Fe- male		No.	Died		Average Period of C'valescence (days)	No.	Died		Average Period of C'valescence (days)
						No.	%			No.	%	
Liver	87	41	46	42	67	14	20	54.5	20	1		19
Lung	10	4	6	5	8	2	25	34	2	0	5	14
Omentum	7	2	5	4	2	0		30	5	0		17
Abdominal wall	6	1	5	0	2	0		27	4	0		19
Retro- peritoneal	5	2	3	1	2	0		20.5	3	0		17
Abdominal cavity	4	0	4	1	3	0		51	1	1	100	
Kidney	4	3	1	1	3	2	66	60	1	0		99
Spine	2	2	0	1	1	0		49	1	0		37
Pelvis	2	2	0	2	2	0		27.5				
Thigh	2	1	1	2	2	0		16	1	1	100	
Ilium	2	2	0	0	1	0		33	1	0		19
Spleen	1	0	1	1	1	1	100					
Femur	1	0	1	1	1	1						
Uterus	1			1	1	0		42				
Thyroid	1	0	1	1	1	0		12				
Brain	1	1	0	1	1	1	100					

advocate of its use, has employed it in strengths of up to 20% and more. He has demonstrated the poor absorptive power of the thick fibrous adventitia which is usually present in cases of hydatid of the liver and other abdominal viscera.

To insure the destruction of hydatid elements which may have remained in the adventitial sac, Mr. Kilvington injects a quantity of "Formalin" solution into the sac which is allowed to remain when sutured. In large hydatid cysts as much as forty-five cubic centimetres of a 10% dilution has been enclosed. It is probable that in addition to the destruction of hydatid elements and organisms the "Formalin" leads to a more rapid shrinkage and filling up by granulation tissue of the adventitial sac.

Though toxicologists regard "Formalin" as being but feebly poisonous, it is known to have produced severe toxic symptoms and even death. I have consequently

thought necessary. The wound in the parietes is closed without drainage.

In one or two instances when I have felt insecure in regard to the suturing, I have anchored the suture line of the adventitia to the upper or lower part of the peritoneal suture line of the wound. It is important that the incision into the cyst should be made through a part of the adventitia which subsequently allows of secure suturing.

I now propose to submit to you as a basis for discussion a critical analysis of the cases of hydatid disease surgically treated at the Melbourne Hospital during the period from 1917 to 1922 (both inclusive). I have chosen these years because they embrace the period when newer methods have come into more general use.

It should be stated that whilst of the whole series 28% were treated without drainage, of the last fifty, 40% were so treated. Reviewing my own cases I now feel that a

number of cysts which were drained, could have been closed without drainage and that such procedure would have been equally if not more safe and insured a more rapid convalescence.

No reference has been made to the newer methods of diagnosis, but the high percentage of the erroneous provisional diagnosis emphasizes their importance.

TABLE II.

Analysis of cases of Hydatid Disease with erroneous provisional diagnosis (Melbourne Hospital, 1917-1922).

Situation of Cyst	Number	Provisional Diagnosis
Liver	42	Cyolecystitis or cholelithiasis (17), gastric malignant disease or ulcer (6), renal conditions (4), general peritonitis (ruptured appendix) (3), ulcercy with effusions (2), hepatomegaly (2), appendicitis (2), abdominal ascites and malignant disease (1), hepatic cirrhosis (1), pancreatic cyst (1), chronic pancreatitis (1), carcinoma coli (1), subphrenic abscess (1), inflammatory tumor (1).
Lung	5	Empyema or pleurisy with effusion.
Omentum	4	Ovarian tumor (2), myoma uteri (1), pyosalpinx (1).
Pelvis	2	Intestinal obstruction (1), pelvic appendix (1).
Retro-peritoneal	1	Intestinal obstruction, malignant disease.
Abdomen	1	Malignant ovarian tumour.
Kidney	1	Acute abdominal process.
Spine	1	Tuberculosis abscess.
Spleen	1	Splenomegaly.
Nemur	1	Ununited fracture, femoral hernia.
Uterus	1	Pelvic tumour.
Thigh	2	Sarcoma or lipoma (1), enlarged lymphatic glands (1).
Thyroid	1	Cystic Adenoma.
Brain	1	Encephalitis lethargica.

To illustrate the difficulties that may occur with the employment of the ordinary methods of diagnosis I will quote the details of the following two cases.

1. J.D., a male, *aetatis* forty-seven years, was admitted under my care on November 10, 1917. He complained of recurring attacks of abdominal pain followed by jaundice. The first attack occurred four months previous to admission. Its onset was sudden with severe pain; this was followed by jaundice which lasted for eight days. A second attack three months later was ushered in by pain and a rigor, the jaundice which followed lasted for five days. A similar attack occurred a week later. Examination did not disclose anything abnormal. No tumour or mass was palpable. The provisional diagnosis was that of stone in the common duct.

At operation it was found that the gall bladder was small, that there was a mass projecting on the under-surface of the liver in the region of the junction of the cystic and hepatic ducts. On incision it was found that this was a hydatid which had ruptured and partly discharged into the common duct.

2. M.W., a woman, *aetatis* forty-seven years, was admitted under my care on August 25, 1919. She was sent in by a physician, a specialist in gastric diseases. She

had been under his treatment for nine months for symptoms and signs of gastric ulcer. Temporary improvement had been followed by increasing pain and much loss of weight. An indefinite mass was palpable in the right epigastric region. The X-ray report gave the diagnosis of pyloric obstruction probably due to a neoplasm. Operation disclosed an old calcified hydatid attached to the under surface of the liver.

TABLE III.

Comparison between Cases of Hydatid Disease (Mortality Rate and Rapidity of Convalescence) Treated by Operation and Drainage and Operation without Drainage (with and without use of "Formalin.")

Treatment	Number of Patients	Deaths	Mortality	Average Convalescence (days)
Operation and drainage	97	21	21.6 per cent.	47
Operation and no drainage	39	3	7.7 per cent.	19
"Formalin" and no drainage	21	3	14.3 per cent.	20.3
No drainage only	18	0		18

Note. Of deaths in those operated and drained four occurred in septic cases which had ruptured or infected the peritoneal cavity before operation.

TABLE IV.

Comparison of Grouping of Undrained Cases.

Position of Parasite	"FORMALIN" & NO DRAINAGE		NO DRAINAGE	
	Number	Deaths	No.	Deaths
Liver	12	1	8	0
Abdominal Wall	1	0	2	0
Omentum	1	0	4	0
Retroperitoneal	3	0	—	—
Ilium	1	0	—	—
Thigh (suppurating)	1	1	—	—
Spine	1	0	—	—
Abdomen	1	1	—	—
Kidney	—	—	1	0
Lung	—	—	2	0

Of the deaths three which occurred in patients operated on and closed without drainage, the details are as follows:

1. The first was in a man aged fifty-seven years who had been operated on for hydatid disease of the liver seven years previously. The recurrence was in the site of the original cyst. The cyst was removed, the adventitia cleaned out, some 10% dilution of "Formalin" left in the adventitial cavity and the opening closed. Death occurred four days later. The *post mortem* finding was a collapsed sac. Microscopical examination disclosed cirrhotic and fatty degenerative changes of the liver. The pathologist attributed death to heart failure and possible insufficiency of liver function.

The second was in a man aged sixty-five years with a suppurating hydatid of the thigh which extended from the

tuber ischii to the knee joint. In this patient the adventitial cavity was flushed out with saline solution and then with a 10% dilution of "Formalin." The record states that the patient vomited all night after the operation and that the vomit smelt of "formaldehyde." The wound was opened twenty-four hours after the operation. The patient died twelve hours later. The *post mortem* examination showed the presence of old aortic disease, a flabby myocardium, thickened pericardium with milky patches. The kidneys were congested. The pathologist attributed death to "Formalin" poisoning and cardiac failure. The third was in a woman, aged forty-seven years, with very extensive generalized hydatid disease of the abdomen. She had a pulse rate of 110 on admission with a poor volume and tension. At the operation about ten cysts were opened and emptied, many more remained, but her condition was so bad that the operation had to be brought to a close. Altogether about one hundred and eighty cubic centimetres (six ounces) of a 10% dilution of "Formalin" were left in the adventitial cavities. The patient did not rally after the operation and death occurred within twenty-four hours. The *post mortem* examination did not disclose anything definite apart from numerous additional hydatid cysts. The pathologist attributed death to post-operative shock.

In only one of the three would the "Formalin" seem to be associated with the cause of death and in that patient it appears that there was an absence of the thick fibrous adventitia with low absorptive power. (This patient I should state was not under Mr. Kilvington's care).

My object in bringing before your notice the foregoing statistical tables is not to advocate any one method of treatment in every case of hydatid disease, but rather to throw into bold relief certain differences in the results obtained by various methods. There were important variations in the character of the cases of the several series. These it is difficult to show in tables of figures, yet allowance should be made for them.

The method best suited for the treatment of a case of hydatid disease depends on a number of factors, to wit, the location of the parasite, whether it is the seat of pyogenic infection and the virulence of such infection, the character of the adventitia, as to whether the adventitia can be removed or securely sutured and the prevention of recurrence.

The tables which have been presented will serve as a basis for discussion as to the best method of treatment for any particular case.

HYDATID DISEASE OF THE TIBIA.

By ALFRED AUSTIN LONDON, M.D. (London),
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HENRY W. *actatis* twenty-seven years, dismounting from his bicycle one afternoon when he had slowed down near the kerb stone of the pavement, managed to get his leg entangled with the wheel. Both rider and bicycle fell and in falling the patient felt his left leg break. He was taken first to the Adelaide Hospital, but removed the same evening (November 8, 1900), to a private hospital. On examination I found that both bones of the left leg were broken. The fracture of the tibia appeared to be a spiral torsion fracture at the junction of the third and the lowest fourths of the bone with complete separation of a superficial wedge of the shin about five centimetres in its longest

measurements. The fibula was broken at the same level. There was much displacement outwards of the lower end of the upper fragment which was overriding the malleolar end and had penetrated the skin, thus causing a trivial compound fracture.

Considerable difficulties were encountered in the treatment of the case. The compound fracture of the fibula soon became simple and could be disregarded, but a satisfactory adjustment of the fragments of the tibia seemed impossible. I began to think that I had lost any skill that I might have acquired during a house surgeons'hip of several years in a large infirmary in England. Finally I tried plaster of Paris. At the end of six weeks I had a skiagram taken of which I show you a copy. The result of treatment was such that during the two months' holiday I spent in New Zealand I was worried with dreams of actions for malpraxis and ununited fracture.

I returned to Adelaide and saw the patient again on March 1, 1901. He was getting about with crutches. He weighed 50.8 kilograms (eight stone nine pounds) instead of 58 kilograms (nine stone two pounds), as he did in October, 1900. There was great overlapping of the fibular fragments though they appeared to be firmly united. The tibia was, however, still ununited and over the site of the fracture there was a swelling which felt like a large ganglion. On pricking this fluctuating lump with a tenotome a "melon-seed body" was squeezed out. It was not examined under the microscope and did not look like hydatid membrane.

On March 8 (with the assistance of Drs. Gunson and Cudmore) I examined the leg under ether, intending to unite the fracture. The supposed ganglion was incised and there immediately escaped a number of daughter hydatid cysts. Enlarging the incision I found that they were escaping from under the edge of the loose fragment of shin bone before-mentioned. This was removed and a cavity, stuffed with hydatids, was found, which was enclosed by bone of almost egg-shell tenuity and which was about the size and shape of a small lemon. It extended downwards nearly to the ankle joint and half way up the tibia. The cavity was well scraped out and flushed with lotion. It was then swabbed with zinc chloride solution. Several detached cysts and riddled fragments of bone were extracted and the thin egg-shell ends cautiously wired with silver and the cavity drained.

Next day at the friends' request a consultation was held with Dr. Poulton whose opinion was so unfavourable that he strongly urged the patient to submit to amputation of the limb. Professor Watson agreed with this opinion. The patient, however, preferred to give the leg a longer chance and the result has so far justified his choice.

The patient soon went home. The sinus closed up very nearly; only a little serum and an occasional cyst escaping from it. In July he could dispense with a stick in walking. He gained weight and improved in general health and ability to get about. At this date, too, he acquired Hunterian chancre, the treatment of which was considerably handicapped by the patient's intolerance of mercury. In August the sinus was re-explored under ether, as a swelling had formed in the neighbourhood. We found cysts in a sub-cutaneous cavity and some cloacæ in the new bone which led to a much diminished cavity in the interior of the tibia. Not much good was done by the exploration, but a few cysts escaped afterwards, whilst the sinus was not actually closed till about the anniversary of the accident. It subsequently re-opened and some more cysts escaped. On May 16, 1902, it was again explored and scraped and again a few more cysts were removed. This time the sinus soon healed and in October, 1902, the

patient was shown at our meeting. He has since remained quite well and has been able to play football. He told me on May 30, 1923, that at the time of his first operation in 1901 he had vomited and had brought up three cupfuls of cysts, some as big as eggs, many as small as sago; the vomit had been thrown away and he thought nothing more of it, until he saw the specimen of cysts removed from his leg.

MR. R. HAMILTON RUSSELL said that he wished to point out that the method of operating ascribed to him by Dr. Stewart McKay was not the one he used. His method was to remove the parasite and close the adventitia on a full volume of saline solution; it was based on Nature's method of cure in which the hydatid died and became converted into a buttery mass which was gradually absorbed. In liver hydatids the bile ducts might be in communication with the cyst, but the intra-cystic pressure prevented the entrance of bile. After removal of the cyst it was necessary to reproduce this pressure by the instillation of fluid such as saline solution.

The operation of leaving the cyst widely open would be satisfactory were it not for the danger of the entry of bile after the relief of the intra-cystic pressure. He instanced two similar patients treated in different ways. The first, a female, was extremely ill, exhibiting high temperature and jaundice; at operation much offensive, bile-stained, suppurating hydatid material was evacuated and drainage was established anteriorly and posteriorly. Within two or three days the foul-smelling discharge increased, the patient became rapidly worse and died from the effects of a sudden gush of hæmorrhage. At the *post mortem* examination it was shown that a large branch of the hepatic vein had been opened by sloughing.

A short time afterwards he met with precisely similar conditions in a male patient. In view of the former experience he emptied the cavity and in desperation filled it with saline solution and closed it, although he knew that a large bile duct was open. The man rapidly improved and although the wound in the abdominal wall became infected, this did not interfere with his rapid convalescence.

DR. D. MURRAY MORTON said that for thirty years he had watched the evolution of the treatment of hydatid disease. Originally after drainage of the sac following evacuation of the cyst the patients were left with discharging sinuses for months or even years. Some years ago he published a short note on the method employed by himself; it was practically Posada's method and consisted of incision of the cyst, evacuation of its contents, closure and dropping back into the abdomen. This procedure was not applicable to cysts of the lung. A fatality occurred in a patient of the type referred to by Dr. McKay, in whom a second cyst was present behind the one opened and subsequently burst.

He was not convinced of the value of methods in which fluids were enclosed in the sac.

Dévé had shown that there was real danger in allowing the cyst contents to escape. A type of cyst which was unsuitable for closure, was that in close relation to the bowel. In one such case in which three cysts were present, he had used Posada's method; two of the cysts gave no trouble, but the third became infected and a large pelvic abscess developed which had to be evacuated *per rectum*.

He hoped that while some of the pioneers in the treatment of hydatid disease were still alive, some attempt would be made to compile a system dealing with the treatment of the disease as seen in Australia.

MR. BASIL KILVINGTON said that there was a general feeling against the use of the drainage tube except in the case of hydatid of the lung. He proposed to confine his remarks to the reasons influencing him in the use of the "Formalin" method. The rationale of the method was based on the fact that the absorptive power of the adventitia was very small as judged by its histological appearances and by the fact that after injection of substances such as methylene blue into the cavity, many hours elapsed before they appeared in the urine. In one instance this interval was forty-eight hours. Further, suppurating hydatid cysts did not give rise to the same rise of temperature and constitutional symptoms as other abscesses of similar size.

He did not advise the use of more than thirty cubic centimetres of a 10% dilution of "Formalin." It was desirable that the cyst should be allowed to collapse and the use of three cubic centimetres of "Formalin" solution did not prevent this.

He made reference to one of his patients in whom the cyst was a serious cyst of the liver, probably caused by some congenital malformation of the bile ducts. He did not suggest the use of "Formalin" in such a condition.

The only instance in which he thought that the use of "Formalin" might have been a factor in the death of the patient, was that of an enormous hydatid cyst of the thigh with a thin, poorly developed adventitia. The routine use of "Formalin" might have to be considered further, but it might be of great benefit in loculated cysts when it was difficult or impossible to evacuate the contents completely through the main cavity. "Formalin" might destroy the remaining parasites. It might be of benefit in multiple cysts of the abdomen when it was obviously impossible to remove them all surgically. Injection of the individual cysts with three or four drops of the "Formalin" solution with a small syringe might bring about the death of the parasite.

SIR WILLIAM MACEWEN wished to thank the speakers for the instruction he had received from the papers contributed. Hydatids were not commonly seen in Great Britain; he had not seen more than a dozen examples in the whole of his experience. He had seen many operations for hydatid disease since his arrival in Australia and he did not propose to address himself to the treatment of the disease. He merely wished to thank the speakers.

DR. R. GORDON CRAIG said that it appeared to him that there was not much real difference between the methods adopted by various speakers; he felt that the counsel of those who suggested anchoring the closed cyst to the parietal wound, with or without the introduction of fluids therein, was sound. It avoided the dangers of drainage of the loculated cyst and did not militate against rapid healing. If this were not done, extensive general infestation of the peritoneum might occur if daughter cysts escaped into the peritoneal cavity. A certain amount of confusion was apt to arise from the fact that what used to be called the *ecto-cyst* in old terminology was now called the adventitia. He hoped that there would be some practical outcome from the suggestion of Dr. Murray Morton that an Australian contribution to the study of hydatid disease should be made.

THE POSTURAL INFLUENCE OF THE
SYMPATHETIC NERVOUS SYSTEM.

By JOHN I. HUNTER, M.B., CH.M.,
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In his article on "The Sympathetic and other Related System of Nerves" in Schäfer's "Text Book of Physiology" Langley (1) adopted the general term "autonomic" for the contractile cells, unstriated muscle, cardiac muscle and gland cells of the body, together with the nerve cells and fibres in connexion with them. He then subdivided the autonomic nervous system into the sympathetic system consisting of the ganglion and nerves connected with the thoraco-lumbar outflow and the cranial and sacral outflows which may be conveniently grouped together as the parasympathetic nervous system [see Langdon Brown (2)].

The purpose of this paper is to define the physiological principle that a very general and important influence of the sympathetic system is to supply impulses which act constantly upon certain fundamental systems of organs to maintain the posture assumed at any given time by these structures. The cerebro-spinal system and the parasympathetic system exert an intermittent activity upon the structures under the constant influence of the sympathetic system. As will be shown this general principle obtains for the voluntary musculature, the blood vessels and certain hollow viscera, all of which are supplied by two sets of nerve fibres from different sources.

Exceptions to this general plan are to be found and nerves of both functional types in some cases seem to accompany one another from the same sympathetic system. Gaskell (3) concludes, for instance, drawing largely upon the work of Dale, that the uro-genito-dermal musculature receives both motor and inhibitory nerves from the thoracic-lumbar outflow. Moreover, certain nerves such as the vagus to the small intestine show upon stimulation an initial reaction which is the direct opposite to the ultimate reaction. The vagus first inhibits and then excites to contraction the intestinal muscle and in the case of the bladder in some animals at least both inhibitory and motor fibres are supplied by the hypogastric nerves of the sympathetic outflow.

In the last ten years various observers have conclusively shown that the sympathetic system sends a contribution to voluntary muscle in addition to the structures enumerated by Langley (1). The function of this innovation has so far been very obscure. But the work of Royle (4) shows consistent diminution of tone of the voluntary musculature of the lower limb on the side on which the sympathetic innervation was removed in normal, spinal and decerebrate animals. An analysis of the effect of such an operation in the decerebrate animal shows that the plastic tonus of Sherrington (5) is absent. On the intact side a condition of rigid extension is assumed and when spontaneous relaxation of this condition occurs by mechanical pressure, the plastic tonic state of the limb musculature tends to fix the limbs in any position in which they may then be placed. The musculature of the limb from which the sympathetic innervation is removed, fails to remain extended, the limb falling into an abducted and flexed attitude as a result of the action of gravity. Further

the muscle has lost the property which enables it to maintain the limb in any position in which it may be placed. Similar results are seen when the operation is performed on spinal or normal animals (6).

In these experiments Royle removed the sympathetic chain on one side at least seven days before decerebrating the animal. This factor has probably been responsible for the consistency in which tone is diminished. It is noticeable that the most marked contrast between the two limbs after such an operation was to be seen in the animal in which the interval between the two parts of the operation was the greatest, namely seventy-three days. Has a change occurred in the muscle following removal of its sympathetic innervation which has deprived the muscle of the properties resulting from plastic tonus? If Frank's suggestion (7) be true that the ordinary motor fibres supply the fibrils which are concerned in phasic contractions, and the sympathetic fibres the sarcoplasm concerned in tonic contractions, it is suggestive that the denervated sarcoplasm may undergo changes leading to a progressive diminution of plastic tone. This would explain the consistent success of this series of experiments compared with those in which no such interval of time was allowed. The problem of the relationship of dual innervation to the dual structure of voluntary muscle will be dealt with in a further communication.

Tone does not entirely disappear in any of these animals. Contractile tonus [Langelaan (8)] which is subserved by the ordinary sensori-motor reflex arc remains. The tendon reflexes are still present and the somatic reflex connexions may act selectively on different groups of muscles so endowing a posture on the part, for example, extension in decerebrate rigidity. This posture, however, is not rigidly maintained, for plastic tone is absent. Mechanical forces including the action of gravity tend to undo the result of selective reflex action or alter a position attained as a result of passive movement.

In spastic paralysis both these elements of tone are increased as in experimental decerebrate rigidity. Royle's human operations show that the increased plastic tonus in such a condition is responsible for the rigidity of the limb. The removal of the sympathetic connexions to voluntary muscles by severing gray *rami communicantes* enables any cerebro-spinal control which still remains, to act on the limbs to effect a change of position. This helps to restore the power of the patient to balance the body on the lower extremities by allowing, as Royle suggests, rapid alteration of the degree of contraction of muscle groups according to the altering position of gravity.

The consistent diminution of plastic tone obtained in these human operations decides the debated question as to whether the sympathetic system has any relation to the tone of voluntary muscle. It appears further that this innervation is concerned with that aspect of tone which leads to the maintenance of posture. The cerebro-spinal connexions enable new positions, such as those of a limb, to be assumed. At the completion of the movement the involuntary sympathetic mechanism maintains the limb in this position; this result is obtained, it is probable, with less expenditure of energy than if the cerebro-spinal mechanism were constantly in action for this purpose ([Bayliss (9)]).

This effect of the sympathetic innervation upon the posture of voluntary muscles is closely analogous with the action of the sympathetic nervous system upon hollow viscera. This has been dealt with at some length in my former paper (*loco citato*). The function of the sympathetic control of the rectum, for instance, is to regulate the posture of the wall to allow of filling of the gut. This is a constant activity allowing gradual relaxation of the wall and maintaining contraction of the sphincter. Just that degree of tone necessary at various phases of the process is maintained by this influence. Emptying occurs intermittently by vigorous contraction of the bowel wall and relaxation of the sphincter as a result of an adequate stimulus to the sacral parasympathetic fibres. This action is comparable to the phasic variation brought about by the cerebro-spinal nerves to voluntary muscle.

The blood-vessels also have the calibre appropriate to the needs of the part they supply under the control of the sympathetic outflow. Special vaso-dilator nerves intermittently cause dilatation. This activity which is carried on through special fibres in the posterior nerve roots, is comparable to the intermittent action of the parasympathetic sacral fibres upon the rectum and the cerebro-spinal nerves upon voluntary muscles.

It would appear that the sympathetic outflow exercises a constant influence, determining posture of muscle of organs, blood-vessels and of the body wall and limbs. By reflex or voluntary action additional systems lead to alteration of the posture. Vaso-dilator nerves have this influence on blood vessels. The sacral and bulbar parasympathetic outflow acts intermittently upon viscera. Cerebro-spinal nerves establish a voluntary control over striated musculature. The phenomenon of double innervation is a general one. The double innervation of voluntary muscle is a special instance of this general condition and the function of the two sets of nerve fibres is similar to the function of the corresponding sets of fibres which control blood-vessels and viscera.

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THE PROBLEM OF TREATMENT OF SPASTIC PARALYSIS.

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MUSCULAR rigidity is the greatest factor in the production of the disabilities and deformities of spastic paralysis. It minimizes whatever control the patient may have over his muscles and it involves the patient in a wearying process of striving to produce movements against a continual resistance. Current methods of treatment upon the accepted physiology of spastic paralysis have to a certain extent alleviated the sufferer's condition, but have failed to remove the rigidity. From a clinical study of the effects of treatment it is evident that some other factor must be involved in the production of rigidity than the influence which is usually attributed to the medullated nerves. Boeke and others have shown that voluntary muscles are supplied by non-medullated fibres from the sympathetic system in addition to the medullated fibres from the anterior horn cells and this has opened up a new avenue for investigation into the mechanism of the control of movements.

De Boer sectioned the sympathetic fibres supplying muscles and claimed that he produced a change in the tonic condition. Langelan, accepting de Boer's results, maintained that the sympathetic nerves were concerned with the maintenance of "plastic tone," whereas the ordinary medullated nerves were concerned with the production of "contractile tone." De Boer's experiments were repeated by Kuno who formed the opinion that the results obtained were due to the vasodilatation in the limbs deprived of their sympathetic supply. But a much more serious objection to the theory is that according to the results of a number of experimenters, section of the sympathetic fibres fails to influence the development and maintenance of decerebrate rigidity. This condition follows the section of the mesencephalon in animals and is generally admitted to be due to a great increase in the tone of muscles maintaining the animal against the effects of gravity. Dusser de Barenne, Van Rijnberk and Cobb each carried out experiments by destroying the abdominal sympathetic trunk on one side either before or after decerebration. Dusser de Barenne found a diminution in tone in five cases out of nine; Van Rijnberk could detect no constant difference in nineteen experiments and Cobb found none in a series of six.

Similar experiments are reported by other observers and the results have been summed up by Adrian who comes to the conclusion that all the recognized phenomena of tone can be produced in muscles which have been deprived of their sympathetic supply and that the only reason for supposing that the sympathetic fibres have any function at all, is the fact that they exist. In a later contribution this view is supported by F. M. R. Walshe.

J. T. Wilson in reviewing the question from the morphological side, comes to the conclusion: (i.) That it is impossible to deny the presence of non-medullated fibres in voluntary muscles which are hypolemmal in their mode of distribution, (ii.) that these relationships, if admitted,

would seem to indicate a centrifugal conduction along these nerve fibre paths by nerve impulses presumably of motor and possibly of tonic contractile character.

Experiments to Determine the Function of Sympathetic Nerves Supplying Voluntary Muscles.

In the light of the above reviews it is obvious that the function of sympathetic fibres going to voluntary muscles has not been definitely determined. Experiments were therefore devised to find out the function of the sympathetic fibres and whether that function had any relationship to the rigidity of spastic paralysis.

The research was conducted from the clinical point of view with a hope of finding a method of diminishing the rigidity in spastic paralysis and the undetermined function of the sympathetic nerves supplying voluntary muscles afforded a field for investigation.

Three sets of experiments were carried out. The abdominal sympathetic trunk on the left side was removed in the normal animal, in animals with the spinal cord divided and in animals in which decerebrate rigidity was produced later. In all three conditions similar changes were observed. In the normal animal it was found that the ability to control the voluntary muscles was not interfered with, but reflex activity was diminished. In addition, although the animal could apparently stand in a normal manner if placed on its back, it could not maintain the left lower limb in the same degree of extension as the right lower limb. The voluntary resistance to passive movement was also diminished on the left side. In the spinal animals the increase in tone which follows section of the cord, was not present on the left side and the limb, instead of being held in a flexed and adducted position, fell into extension and abduction under the action of mechanical forces. The most marked changes were seen in the decerebrate animals. The division of the left abdominal sympathetic trunk prevented the onset of decerebrate rigidity in the left lower limb, but the limb participated in the periodical extending movements only to fall into flexion immediately. When the left limb went into extension, it could be easily flexed, whereas the greatest force had to be used to put the right limb into the flexed attitude. The experiments in decerebrate animals were carried out by removing the abdominal sympathetic trunk at one operation and allowing the animal to recover before the brain was removed. This had a very definite effect upon the results obtained and it was noticed that the contrast in the condition of the two lower limbs varied with the length of time between the two operations. The least striking changes were seen at the end of eight days after the removal of the sympathetic trunk and the most striking changes were seen when the animal was decerebrated at the end of seventy-three days. The whole of the experimental evidence showed that removal of the sympathetic nerves produced a great diminution in the tonic condition of the left lower limb. The reflexes were less easily elicited and were less in amplitude though they did not disappear. It also produced a loss of ability to maintain posture against the effect of gravity in the left lower limb and in the decerebrate animal such an effect that rigidity did not appear in the left lower limb.

These differences in all the experiment animals were so

marked and so constant that it was considered justifiable to test the therapeutic value of the observation and endeavour to find some relief for the rigidity accompanying spastic paralysis in the human subject.

Changes in the Human Subject.

Patient A. C. had suffered for seven years from the effects of a gunshot wound of the cerebral cortex. The bullet had entered his skull just above the left ear and had caused an extensive laceration of the cerebral hemisphere in the region of the central sulcus of the left side and had extended across the middle line to the opposite cerebral hemisphere. After the receipt of injury the patient was unable to speak for three months and was unable to walk for three years. Spastic hemiplegia was present on the right side of the body and the left lower limb was affected but only in the leg and foot. The knee jerk of the left lower limb was normal; the ankle jerk was exaggerated and there was an ankle clonus. On the right side there was an exaggerated knee jerk, an ankle clonus, a patella clonus and an increase in the ankle jerk. The patient could walk, but had the greatest difficulty in controlling his right lower limb which he moved as one rigid piece. When weight was placed on the limb, a coarse uncontrollable tremor appeared. He could only move forwards; lateral or backward walking could not be carried out. *Talipes equinus*, due to structural changes in the calf muscles, was present on the right side. This patient was also subject to occasional tonic fits of short duration and which could be easily controlled by the administration of sedatives. The control of his genito-urinary system was normal, but the patient suffered from chronic constipation.

The Operation.

The right abdominal sympathetic trunk was approached through an incision which extended from the last rib to the crest of the ilium and thence forward for about 7.5 centimetres. The lumbo-dorsal fascia was divided at the lateral side of the *sacro-spinalis* and the oblique muscles were freed from the crest of the ilium for about five centimetres. The left hand was then passed behind the peritoneum and in front of the fascia covering the *quadratus lumborum* and the *psaos* muscles until the vertebral column was reached. Retractors were then placed in position and the right abdominal sympathetic trunk was exposed. There are difficulties in doing this owing to the depth of the wound and defective lighting. The abdominal sympathetic trunk is not difficult to recognize in the living subject and was exposed from the second lumbar vertebrae to where it disappears under the iliac vein. The white ramus from the second lumbar nerve was then divided and the gray rami going to the second, third and fourth lumbar nerves were avulsed.

The fourth lumbar ganglion was then defined and the sympathetic trunk was divided immediately below. By this means the gray *rami communicantes* to the fifth lumbar nerves and to the sacral nerves were divided.

The patient had very little discomfort following the operation and there were no evident alterations at first to the functions of the bladder and the rectum. When the patient was examined six hours after the operation many

changes were evident. The right lower limb was a brighter colour than the left and there was evidence of capillary dilatation. The limb also felt warmer, but there was no difference registered on a clinical thermometer. There was no oedema, but on measuring the circumference of the calf the right was about one centimetre larger than the left. The muscles of the right lower limb were also undergoing coarse fasciculation which disappeared when the muscles were completely relaxed. This fasciculation continued for about ten days after the operation. On comparing the right leg and foot with the left there was considerable contrast in the spastic condition. If the left foot were passively pushed into dorsi flexion there was a tendency for this position to be maintained and the attitude was only gradually relaxed. On the right side, however, passive dorsi-flexion of the foot was followed by immediate and complete relaxation. The knee jerk was still exaggerated and the ankle clonus could still be obtained. The knee jerk and ankle clonus gradually became less evident, so that at the end of twenty-one days there was no ankle clonus and the knee jerk was but slightly more active than normal. The vasomotor disturbances were only of short duration and there was no practical difference in the colour or in the rate of return of colour after pressure in either limb at the end of seventeen days. The patient stood up on the ninth day and it was found that tremor was no longer present in the right lower limb. On the twelfth day the patient was able to walk backwards for the first time since the receipt of his injury and on the nineteenth day the condition had so far improved that he was able to walk up and down steps using each limb alternately to negotiate each step. Gradual and progressive gain in the control of the movements of his lower limb also appeared. Before the operation the only movement which could be done as an isolated action was extension of the knee joint, but since the operation the patient has acquired the ability to control the hip, knee and ankle. This degree of control enables the patient to relax the right lower limb during the phase of movements when weight is taken on the left lower limb and to carry it forward in a manner closely approximating the normal gait.

A striking change has also occurred in the condition of the patient's lower bowel. Before the operation the patient had to resort to the daily administration of purgatives, but since the operation this is no longer necessary as the bowel works quite normally under natural stimuli.

Patient H. C. had suffered from spastic hemiplegia on the right side for fourteen years. The upper limb was useless as there was only the smallest degree of voluntary control in the flexors of the fingers. The whole limb was particularly rigid and the hand was dorsi-flexed at the wrist, flexed at the metacarpo-phalangeal joints, extended at the proximal inter-phalangeal joints and flexed at the distal inter-phalangeal joints. The thumb was dorsi-flexed at the metacarpo-phalangeal joint and flexed at the interphalangeal joint. The forearm was fixed in pronation and could not be even passively supinated. Rigidity was so great that it was impossible to passively flex or extend a finger and the extensors of the wrist resisted forceful passive flexion. The wrist jerk was exaggerated and was followed by a clonus.

The Operation for Spasticity in the Upper Limb.

An incision along the posterior border of the right sterno-mastoid gave access to the brachial plexus. The nerve roots were exposed and traced to their origin behind the scalenus anterior muscle. This muscle was then lifted forward and the *rami communicantes* to the fifth, sixth and seventh cervical nerves were divided. The rami to the eighth nerve and the first thoracic nerve were obtained by carrying the dissection downwards behind the subclavian artery. This approach avoids all important structures in the neck and allows the essential operation to be carried out, that is, the division of the efferent sympathetic fibres to the musculature of the upper limb.

Changes following the Operation.

Immediately after the operation it was evident that the former rigidity had been very much diminished. The wrist could be passively flexed and the fingers could be flexed and extended without any difficulty. Extension at the metacarpo-phalangeal joints could not be passively carried out on account of structural changes that had occurred there. The forearm could be supinated without resistance through an angle of about 45°. The day following the operation the patient discovered that he could voluntarily dorsi-flex the wrist joint and three days later he could supinate his forearm. Reflex activity was very much diminished but the wrist jerk was still easily obtained. Vasomotor disturbance, similar in character to those described in the patient A. C. were observed.

Changes in the Human Subject following Division of the Sympathetic Nerves to Voluntary Muscles.

Diminution of Rigidity.

The most outstanding change that has occurred in these patients is the diminution of rigidity. In each instance also, there was a diminution in the amplitude of reflex movements and a gradual restoration to a normal reflex condition. The diminution of rigidity has restored the patient's balance on the affected limb in one case and has enabled the patients to be able to voluntarily relax the affected muscles in both cases. The loss of balance in spastic paralysis appears to be due to inability to change position quickly. With a diminution of rigidity, change in position is easily effected and alteration in the centre of gravity can be compensated by changes in the state of contraction in the muscles of the lower limb. Tremor, which was such an evident feature in the right lower limb of the patient A. C. before operation, has entirely disappeared. The probable explanation of this depends again upon diminution of rigidity.

Alteration in Muscular Control.

In both patients there was an immediate and progressive gain in control. This is explained by the lessened resistance to performance of any definite movement and from the fact that whatever cerebral control is present can now produce a maximum effect. The mental effort required in performing movements is very much less and the patient can concentrate on changing position and on coordinating various movements.

Vasomotor Disturbances.

Vasomotor disturbances in both of these limbs were only noted during the first week following operation. The changes were characterized by an alteration in colour of the limbs, by inability to obliterate the capillary dilatation and apparently by a slight increase in the size of the limb. This increase was transient only. At the end of a fortnight the vasomotor changes had practically disappeared.

The Possibility of Wasting.

An important question that had to be decided before the sympathetic nerves were cut was whether there would be any wasting following operation. In the case of the experimental animals the difference in weight of the *tibialis anterior* and the *extensor communis digitorum* never exceeded the normal variation that occurs in muscles of the opposite limbs in the same animal. At the end of seventy-three days, for example, the muscles of the normal limb were found to be about 5% lighter than the muscles of the limb from which the sympathetic nerves had been removed. In the human subject there does not appear to be any wasting in the muscles deprived of their sympathetic supply but the operation has been actually followed by a definite increase in power.

Change in the Condition of the Bowels.

One very important result appeared in the patient A. C., and that was the effect following the removal of the white ramus going to the abdominal sympathetic trunk from the second lumbar nerve. In this patient, chronic constipation has been absolutely removed and the bowel now works regularly under the influence of natural stimuli.

Sympathetic Ramisectomy.

In the two patients who submitted to operation, spastic paralysis was present in the worst conceivable form. In both of these instances there has been a remarkable diminution of rigidity with such an increase in the ability

to control movements that the procedure should be effective in practically all cases of spastic paraplegia and hemiplegia. It is reasonable to suppose that the best results will be obtained in those patients who have a fair cortical representation of individual movements. In spastic paraplegia of infancy the difficulties of balance would be very much lessened after section of the sympathetic nerves. The process of physical education will be greatly assisted by this operation, but it is not to be supposed that results will be obtained without efficient after treatment.

Modification of Operative Procedure.

The operation which is described for dealing with spastic paralysis of the lower limb could be modified in this respect. There is actually no need to take out the white ramus from the second lumbar nerve if it is simply desired to attack rigidity in the lower limb. In this instance the division of the white ramus had an effect which was not anticipated but which indicates a possible line of treatment for chronic inactivity of the lower bowel.

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